KNOWLEDGE
AN ILLUSTRATED MAGAZINE OF SCIENCE, LITERATURE & ART.
Founded by RICHARD A. PROCTOR.

Vol. xxvi.] *LONDON: MARCH, 1903.* [No. 209.

CONTENTS.

PAGE

St. Sophia, Constantinople.—II. By E. M. Antoniadi, F.R.A.S. (*Illustrated*) ... 49
Animal Wind-Bags—Useful and Ornamental.—III. Wind-Bags as Danger-Signals and Life-Buoys. By W. P. Pycraft, A.L.S., F.Z.S., etc. (*Illustrated*) ... 52
Giant Land-Tortoises. By R. Lydekker. (*Illustrated*) 54
The Great Marion's Tortoise (*Testudo sumeirei*). (*Plate*)
Modern Cosmogonies.—I. The Nebular Hypothesis. By Agnes M. Clerke ... 57
The Path of the Moon.—II. By A. C. D. Crommelin. (*Illustrated*) ... 59
Letter:
Did the Romans know Aluminium? By A. Dubois 61
Obituary:
Sir George Stokes ... 61
Notes ... 62
British Ornithological Notes. Conducted by Harry F. Witherby, F.Z.S., M.B.O.U. ... 63
Notices of Books ... 64
Books Received ... 65
Familiar British Wild Flowers and their Allies. II.—The Rose Family. By R. Lloyd Praeger, B.A. (*Illustrated*) ... 65
Microscopy. Conducted by M. I. Cross ... 68
Notes on Comets and Meteors. By W. F. Denning, F.R.A.S. (*Illustrated*) ... 69
The Face of the Sky for March. By W. Shackleton, F.R.A.S. (*Illustrated*) ... 70
Chess Column. By C. D. Locock, B.A. ... 71

ST. SOPHIA, CONSTANTINOPLE.

By E. M. Antoniadi, F.R.A.S.

Illustrated from original drawings by the Author.

II.

The Inner Division of the Church.

The first section of the present study on the great cathedral has dealt with its history and outer appearance, and it is now the design of this, as well as of the two succeeding sections, to describe the interior; starting with the inner division of St. Sophia during the 858 years it remained in the hands of the Christians.

To render the argumentation on this subject intelligible it is necessary to accompany it with a plan of the church. Fig. 4, which meets this requirement, is mostly the result of the writer's own direct measurements, except for the now inaccessible parts of the building, where Salzenberg's data* have been utilized. The plan further gives a synthesis of the results of Paul the Silentiary, Constantine Porphyrogenitus, the Anonymous Greek author, Grelot, Neale, Byzantios, Lethaby and Swainson, followed by the writer's analysis.

It should not be assumed that the new interpretation of the inner arrangements of St. Sophia is at all meant to be final or decisive. Such an inquiry, it must be remembered, treads on treacherous ground, where hasty conclusions and unjustified assertions are particularly dangerous. The plan is, therefore, at best, a first approximation, subject to all such modifications as would be rendered imperative by further investigation.

The Ambo or Pulpit.—In modern Greek churches the pulpit is to the left of the nave. But this was not its original position in the great cathedrals of the past. According to the poet, the Ambo of St. Sophia stood "in the sunshiny centre of the nave, but rather inclining eastwards."* Also, Germanos, Patriarch of Constantinople, mentions that "the ambo stands in front of the door of the sanctuary." Again, Symeon of Salonica speaks of "the ambo before the bema," adding that "it is placed opposite the sanctuary, provided the church is spacious enough to allow of such an arrangement."† These remarks leave no doubt as to the position of the pulpit: it was in the middle of the nave, on the great axis, but decidedly nearer the eastern wall. It must have been somewhere under the great arch to the east, in the position assigned to it by Messrs. Lethaby and Swainson,‡ and not under the central square area, as, in that case, it would interfere with the circle of lamps hanging from the cornice of the dome.

The Choir of Singers is described by Paulus as divided into two parts, each half "embraced" by the two eastern exedras.

Sanctuary, Soleas and Imperial Throne.—A curious feature of the ground floor to the east is that, through time or intention, it no longer forms a plane surface. The Bema or Sanctuary is reached to-day by three steps from the west, and by as many from the south, but by only two on the north side. The western steps, constituting the Soleas,§ are now approximately turned towards Mecca, forming an angle of some 18° with the minor axis,‖ so that it is almost impossible to conjecture their original design. Under such circumstances, the disposition given them in the plan is very uncertain, although there can be no doubt that the Soleas was originally much larger than what it is in modern Greek churches.

It would seem that there always was an Imperial Throne somewhere about the Choir or Soleas. True, such a throne is not mentioned by Paulus in the sixth century, nor by Porphyrogenitus in the tenth. But the statements of Sozomenus and Theophanes are eloquent on this point. "The king's place in the church," says the former of these authors, "is in front of the sanctuary, so as to enable him to preside, on one side, over the people and, on the other, over the priests"; while Theophanes remarks that "the custom of having the kings standing outside the sanctuary, with the people, held good" up to his time (9th century). It will be seen on the plan that the Imperial Throne has been placed by the writer to the south, in the position of the modern archiepiscopal throne

* *Altchristliche Baudenkmale von Constantinopel*, Berlin, 1854. It was not without some reluctance that Salzenberg's representations of the annexes now closed were incorporated in Fig. 4, owing to the great untrustworthiness of the German artist, who, although having had unique opportunities with the scaffolding and unveiling of the mosaics in 1848, could not avoid, in his plates, a series of glaring, and, indeed, unaccountable, architectural oversights.

* Paul the Silentiary, *Descriptio Ambonis*, verses 50, 51.

† Du Cange, *S. Sophia*, §74.

‡ *S. Sophia*, Fig. 5.

§ Probably from *soleum*, a throne.

‖ The perpendicular to these steps does not appear to face Mecca, whose azimuth from Constantinople is 331°, so that the faithful, praying in the mosque, and wishing to face the Kaaba, ought to incline slightly to the right.

XUM

of the Greeks. But it might also have been quite close to the Sanctuary, in the position marked A, on Fig. 4, where the marble decoration of the pier shows some curious anomalies, which it is not easy to account for on the basis of other assumptions.

Metatorion.—The word μητατώριον seems to come from *mutatorium*, and meant a vestiary. There were several Metatoria in St. Sophia, but the most important lay south of the Sanctuary, as ably pointed out by Messrs. Lethaby and Swainson.* Paul the Silentiary speaks (verses 165-168) of a "wall" in south aisle, "screening off the king on great feast-days," and enabling him "to hear, from his usual throne, the reading of the books celebrating the holy mysteries"; while we learn from Constantine Porphyrogenitus that, on attending service in the tenth century, the emperor spent a considerable part of his time in the Metatorion, where, of course, there must have been a throne, granting him some rest after the numerous processions he had to attend upon during the celebration of the liturgy.

Annexes of the Sanctuary.—Right and left of the apse, the openings of the eastern wall show evidence of having been originally subordinated to the presence of a series of low attached chambers, whose saddle roofs can still be traced from the south gallery of the church. Not only the windows are opened here at an unusual height, but also the great doors to the east lack centering with reference to the axis of the aisles. Communication with these chambers was ensured from the Sanctuary by two small doors, of which the one to the south is still extant, though blocked up so as to lead only to a shallow recess of the eastern wall.

There is good reason to believe that the *Prothesis*, or table destined to receive the bread and wine for the sacrifice on the Altar, lay in one of the northern chambers (Prothesis I. of the plan), and that most of the other halls constituted the *Sacristy*, *Skeuophylakion*, or *Diaconicon*. The addition of the high buttress masses of Andronicus Paleologos must have introduced serious trouble here, in 1317, by blocking with stone and mortar the all-important annexes. It does not seem improbable, therefore, that, during the last 135 years of the empire's existence, the Prothesis was in the aisle (Prothesis II.), immediately to the left of the Sanctuary; while a special strong circular building had to be erected as Sacristy, outside the north-east angle of the church.

The north porch to the east was the *Women's Narthex*. "On leaving the skeuophylakion," says Porphyrogenitus, "the emperor passes through the women's vestibule, where stand the deaconesses of the great church, and goes out through the left of the sanctuary."†

The Holy Well.—In his work on the Palace of Constantinople, Labarte raised a series of annexes all along the south wall of St. Sophia, for which, however, there is no trace of evidence, architectural or historical; and the fact that these annexes would inevitably block the windows of the southern ailes is a fatal objection to their assumption. Speaking of the celebrated Holy Well, Labarte, in his customary dogmatic spirit, says:—"From the great hall of the holy well one entered the church. It could only be by the great southern door, which still exists in the centre of the edifice." Now the door leading from the Well to the church was quite small, inasmuch as Porphyrogenitus informs us that the Patriarch used to accompany the emperor, leaving St. Sophia "as far as the little door leading to the holy well."* But Labarte commits a graver error than this one. The Holy Well was not to the south, but "probably in one of the eastern chapels," as pointed out by Messrs. Lethaby and Swainson. A Byzantine author, quoted by Combefis, says: "In this honoured and celebrated church, there is a coloured eikon of Christ . . . . painted on a panel near the eastern door, where is the well of the Samaritan woman."† There are two doors in the east front, so that we have to examine if the Well was by the northern or southern of the two. This is easy. According to the testimony of a Russian pilgrim, "the stone on which sat Christ, speaking to the woman of Samaria, was in the chapel to the right."‡ Right means south. Meantime, another Russian pilgrim says that this chapel was behind (east of) the Sanctuary.§ Hence we learn:—

(*a*) That the door between the Holy Well and the church was small;

(*b*) That the Well was in one of the southern divisions of the eastern annexes; and

(*c*) That it was quite close to the great southern gate, on the east side.

Examining our plan, we find that the first of the eastern chambers, close to the gate, will fulfil all these

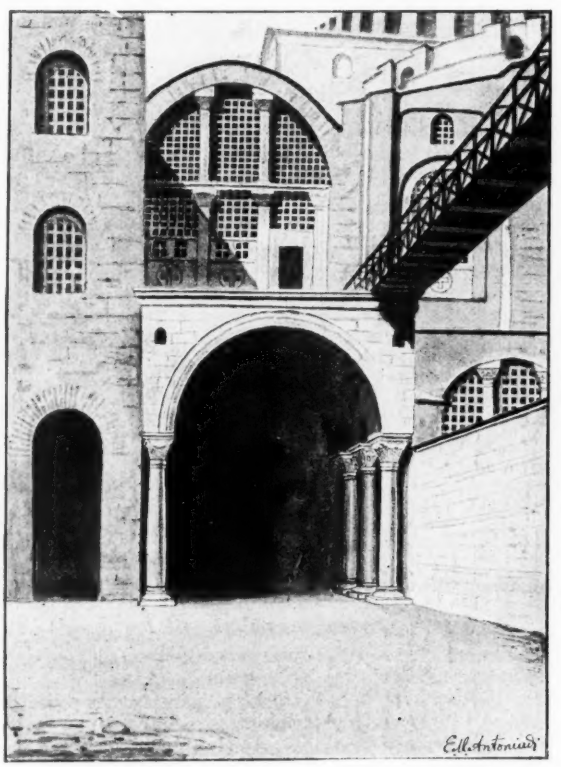


Fig. 5.—Entrance of Holy Well, Door of South-east Window, and Corridor of Mannaura. Epoch: 10th Century.

conditions. It will also be seen that the Embolos (portico) of the Well, mentioned by Porphyrogenitus (Fig. 5), is partly still extant, though reconstructed by the Turks,

* *S. Sophia*, p. 78.

† *Ceremonies*, ed. Bonn, Vol. I., p. 182.

* *Ceremonies*, I., ch. 1.

† Du Cange, *S. Sophia*, §76.

‡ Lethaby and Swainson, *S. Sophia*, p. 109.

§ *Ibid*, p. 105.

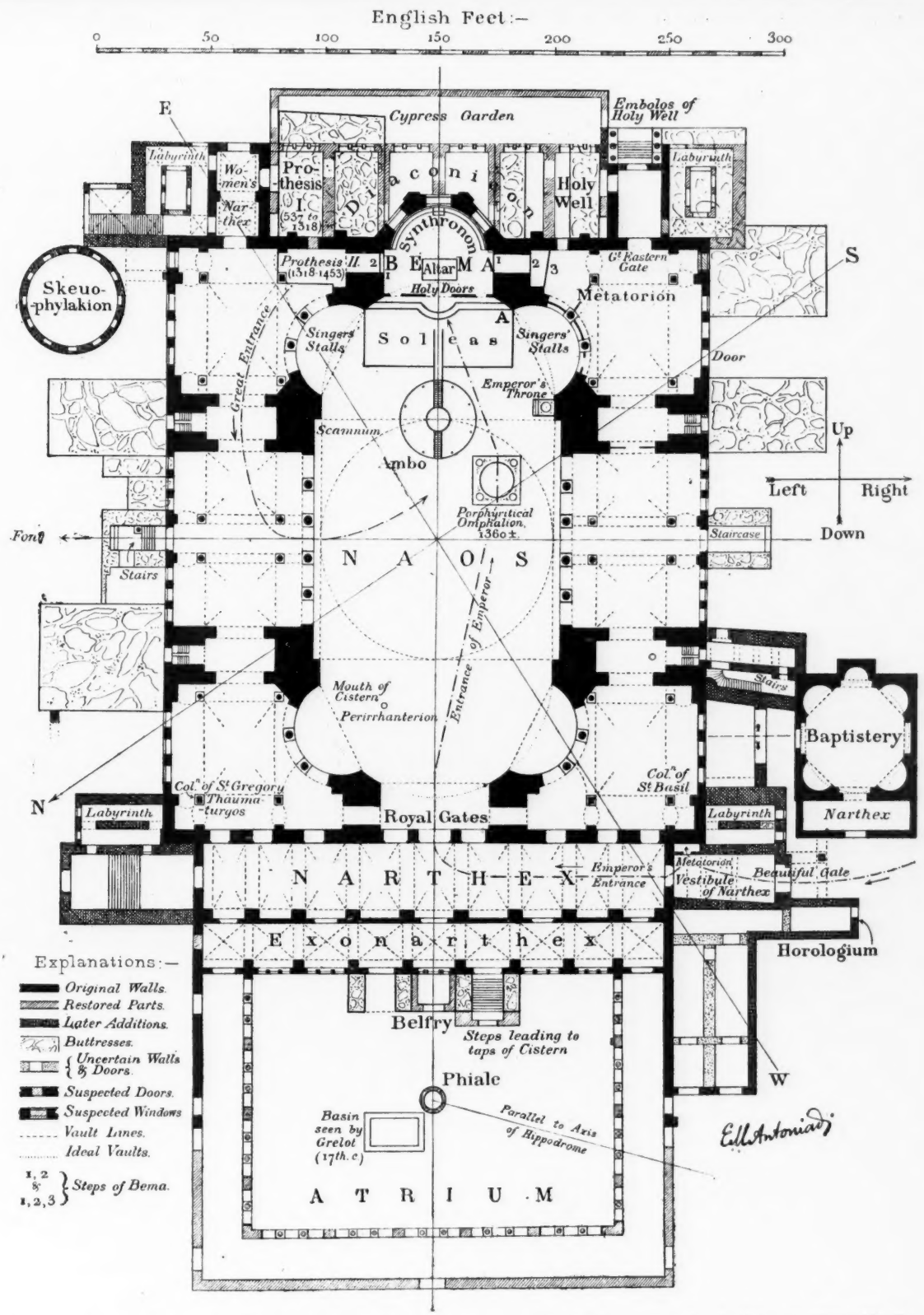


FIG. 4.—General Plan of the Church of the Holy Wisdom, showing the Original Structure, under Justinian, together with all its subsequent known Annexes, up to the year 1453.

XUM

probably with a view to raising its columns to a higher level; the mosque being progressively buried in the ground, through the gradual flattening of the adjacent hill of the acropolis.

The Door of the South-East Window.—In addition to the entrance of the Samaritan Well, Fig. 5 shows a door, still preserved, and opened in the great south window of the east front, in the first floor level, or *Catechumena*. On the 14th September, date of the Exaltation of the Cross, the emperor "guided* by the officers of the cubicle and the royal attendants," says Porphyrogenitus, "passes through the Mannaura and its higher corridors, and, having ascended the wooden staircase, enters into the catechumena of the great church."† Inasmuch as no other window of the southern and eastern gallery is pierced by a door, this entrance of the emperor into the Catechumena could have been effected only by the window in question. The wooden stairs probably began at the portico of the Holy Well, being crowned by a little platform just before the door of the first floor level. The idea of a wooden staircase has been shown to have originated in the desire of furnishing to the sovereign an easy escape in case of riot—a means of communication which could easily be destroyed or burned, so as to leave isolated the palace walls.

The Horologion.—This was a very important annex of St. Sophia. Whenever the emperor wanted to go in great ceremony to the cathedral, he used to accord six receptions to various deputations from the city, the last reception taking place by the Horologion of the great church. "And from thence [the Horologion]," says Porphyrogenitus, "the sovereigns enter by the beautiful gate, and have their crowns removed by the præpositi within the curtain hanging in the recess, that is the vestibule of the narthex."‡ On the other hand, the Anonymous speaks of the Baptistery as being "by the Horologion." Now, to fulfil these conditions, the Horologion must have been outside the main entrance, to the south-west, and close to the Baptistery. It can, therefore, be no matter of mere coincidence that, precisely at this spot, at the extreme western angle of the mosque, but facing 34° west of south, the writer has always seen a sundial of Turkish workmanship Bearing in mind how unchanging everything is in the East, it would not be imprudent to assume that the idea of the Asiatic dial struck its roots in the presence, at this very point, of the sundial erected by Justinus II. and his wife Sophia in the sixth century.

Like Rome, the Mohammedan civilization of Constantinople could not help feeling the influence of Greek art and learning. Neither the difference of race, nor the disparity of manners, nor the contrast of religion could avert a decisive subjugation of the Moslems to the empire of thought bequeathed by the vanquished. The adoption of Byzantine architecture by the Sultans for their religious buildings; the unaltered appearance of the city under the new rule; and the choice, for the national standard, of a Greek emblem, the crescent and star,‡ resting on an astronomical observation twenty-two-and-a-half centuries old, are thus all easily to be accounted for. Imbued with feelings of admiration and reverence for Hellenic genius, the victorious Ottomans soon felt the difficulty of improving upon its masterpieces, and perceived that the real channel for their artistic tastes lay in a close observance of the precepts laid down by the superior science and weightier experience of their enlightened predecessors.

(To be continued.)

* Δηριγενόμενος, from *derigo*.

† *Ceremonies*, I., p. 125.

‡ *Vide* Oman, *The Byzantine Empire*, London, 1892, pp. 4 and 7–8.

ANIMAL WIND-BAGS—USEFUL AND ORNAMENTAL.—III.

WIND-BAGS AS DANGER-SIGNALS AND LIFE-BUOYS.

By W. P. Pycraft, A.L.S., F.Z.S., etc

In concluding this brief survey of the various types of air-sacs to be met with in the animal kingdom, I propose to deal with those which serve the purpose either of terrifying enemies or transforming their possessors into morsels too large and sometimes too dangerous for prowling carnivores to swallow; and, lastly, with those which perform the duties of organs of locomotion. These are, perhaps, the most wonderful and interesting of all, inasmuch as they represent, not parts of, but whole animals, strangely modified for a stranger purpose.

In some cases the whole body is involved in this inflation, whilst in others only certain regions are affected.

The expedient of baffling their would-be devourers by inflating the body with air is a device practised by the globe-fishes of the tropical Atlantic and Indian Oceans. These extraordinary creatures, when hard pressed by some hungry shark, and not too far from the surface, rush up, and thrusting the mouth beyond the water, draw sufficient air into the gullet to inflate the body to such an extent that the fish-like form is exchanged instanter for that of the globe, from which they take their name, This done, they perforce "turn turtle," and float at the surface with the inflated belly well above the water. By this means, like the flotsam of the sea, they are blown along for great distances, the projecting portion of the body catching every breeze that blows, and thus eventually they reach a place of safety. Not always, however, do they escape the fate they flee from, for it occasionally happens that some more than usually greedy shark swallows them, as the sturgeon did Hiawatha. No friendly sea-gulls, however, are at hand to effect a rescue, so the globe-fish, left to his own resources, promptly gnaws a hole through the walls of his prison, and, escaping, leaves his misguided enemy a mere lump of carrion. It seems that when too far from the surface to gain the much desired light cargo of air, the globe-fish effects the necessary distension of the body by taking in great gulps of water. Probably only certain forms of globe-fish can be thus swallowed, for it should be mentioned that the skin of some species is armed with enormous bony spines, so numerous as to form a complete investment for the body.

Frogs and toads, when threatened with danger, generally inflate the body. Some common toads, which the writer has had under observation for some months, when alarmed, crouch down, and suddenly blow themselves out till the flanks rise on either side above the level of the back like two great air-cushions. Apparently this increased bulk is intended to act as a danger signal. If this first line of defence is broken through, then they fall back upon the acid secretions of the skin glands, and their effect upon dogs, for example, is well known.

Some species of frogs have acquired extraordinary powers of inflating the body, so that they look more like bladders than frogs. One species, inhabiting the hills of Perak, like the globe-fish, can inflate the body and float on the surface of the water, remaining motionless with arms and legs outstretched. Possibly this habit is a device meant to deceive their enemies, who mistake the inflated body for a decomposing and unsavoury corpse.

The chamæleon, when its safety is threatened, appears to adopt two diametrically opposed methods to ensure its escape. Pacific methods are first attempted. When it perceives itself to be discovered it first attempts to escape

by disguise, making itself as thin and shadowy as possible by compressing its sides, and then, turning itself so that only the thin edge is presented to the enemy. This done, it next endeavours, by a dexterous turn, to place the twig upon which it is resting between itself and the attacking party. By this ruse it often succeeds in effecting the vanishing trick and disappointing its would-be captor. If, however, this plan fails, then the body is as suddenly transformed by inflation. Thus the passive disguise is thrown off and a threatening attitude assumed which is probably generally successful. This inflation is effected partly by inflating the lungs, which have a quite unique structure, inasmuch as they are produced backwards into several blind finger-like sacs which extend far down the body-cavity, and partly by means of a large air-sac in the throat. The purpose of this sac, however, is by no means concerned exclusively with the work of inflating the throat. It probably serves also as a reservoir for air when the entrance to the windpipe is closed by the peculiar mechanism of the tongue in catching insects; and is used also in the production of a peculiar hissing sound which the creature makes when angry.

An agamoid lizard, *Agama sanquinolenta*, common in the deserts of Turkestan, also resorts to the use of a throat-pouch to make itself appear more formidable. The males of this species are very pugnacious, especially during the breeding season. At this time, when about to attack, the throat-sac is inflated till it attains the size of a walnut, the body is raised upon the legs, the head lowered and turned inside, and the foe stealthily watched. Suddenly, with a dart, the attack is delivered, and, if the fates are propitious, the enemy is routed.

Among birds and mammals, as among the frogs and their kind and the reptiles, the practice of magnifying the size of the body, apparently with a desire to terrify their enemies, is also followed. The birds effect this by erecting the feathers, the mammals by causing the hair to stand on end. Certain of the latter, however, have developed special storm signals. The bladder-nosed and elephant seals have been conspicuously successful in this. The latter is so-called from the snout which is produced into a short trunk, flaccid while the animal is quiet, but capable of being inflated and erected when enraged. The wind is forced in through the roof of the mouth. The old sealers, it is said, used to regard the trunk of the elephant seals they killed as a great delicacy, calling them "snotters." The inflatable headgear of the bladder-nosed seal is no less remarkable than that of its brother of the elephantine nose. Indeed, the two structures are really not very dissimilar; for did the inflatable tissue of the first-named extend forward somewhat further a proboscis precisely similar to that of the elephant seal would result. As large as the rest of the head when fully inflated, this peculiar casque is a purely secondary sexual character, being found only in the males. It seems to be used as a signal of defiance, being raised whenever its owner proposes to give battle to such neighbours as may desire to while away the tedium of doing nothing by a friendly bout with the teeth. At such times a quivering motion is given to this curious casque, and this undoubtedly adds not a little to the effectiveness of its appearance.

The Gavial, one of the Crocodilia, is the only one of all the reptiles which has developed a similar bladder-like structure. In the full-grown male of this species (*Gavialis gangeticus*) the nostrils are seated in the middle of a prominent hump. At the will of the animal this can be inflated like a bag. The recoil of the air down the long nasal passages, consequent on the inflation of this bag, has produced a curious modification of certain bones of the skull, resulting in the formation of a pair of hollow globular swellings of the size of a goose's egg. So little is known about the habits of this creature, in spite of the fact that it is common enough in many of the rivers of India, that the occasions when this bag is used, as well as its exact purpose, has yet to be discovered. Possibly, however, it serves the same purpose as that in the seals just described.

These curious nasal wind-bags are, in all cases, in connection with the nostrils through which they are filled and emptied. This fact recalls the existence of certain

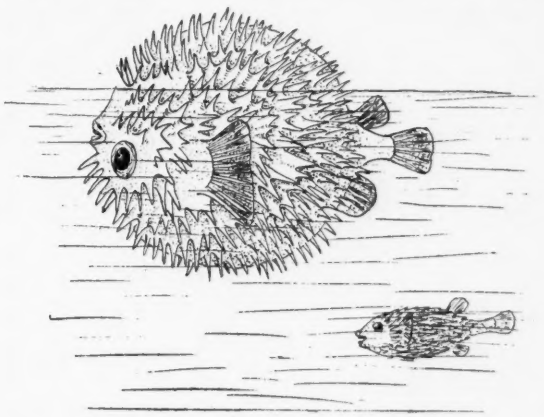


FIG. 1.—The Spotted Globe-Fish, *Diodon maculatus*. The upper figure shows the animal when inflated, floating back downwards, that in the right corner the normal condition.

mysterious air-pouches in connection with the nasal passages, which occur in the horse and the ass, and their relations to the rhinoceros and the tapir. Familiar enough, in the horse at least, to the comparative anatomist and the veterinary surgeon, to whom these structures are known as the "false nostrils," to the general reader their existence is probably quite unknown. Let those who have the opportunity examine carefully the margin of the upper part of the nostril of the horse, when they will find the aperture to what is really a blind pouch, from three to four inches deep, conical in form, and lined with the same smooth skin as that which lines the nasal passage. In the tapir a similar but much more developed pouch is found. In this animal it runs upwards as a narrow tube, at first in conjunction with its fellow of the opposite side, and later separating, each taking a curiously curved or convoluted course, and ultimately terminating in a blind dilatation lodged in a distant groove in the skull bones roofing the snout. In the rhinoceros a similar structure is found, but intermediate in shape between that of the horse and tapir. The "false nostril" of the ass, it should be remarked, is larger than that of the horse.

What the purpose of the pouches in these animals may be is at present a mystery, but they probably are remnants of a once useful structure.

The number of creatures which have adopted the device of imprisoning air, and the variety of uses to which it has been put is indeed striking. So far our survey of this subject has been confined to the higher animals only. Let us now briefly review some of the more striking cases which are to be found among the more lowly animals.

Perhaps the most striking examples to be discovered among these more humble creatures are those furnished by certain jelly-fish which live in colonies and drift about the surface of the open sea, suspended by living life-buoys. In the form known as *Physophora*, for example, an enormously elongated individual undertakes the work of

XUM

transporting his fellows, which number some thousands. To conveniently bear this burden, the body of this second "Atlas" is drawn out into a long stalk-like stem, and around this the various units of the colony are grouped; whilst the upper end of this stalk is dilated to form a large and somewhat pear-shaped bag which, filled with air, forms the float or life-buoy. Immediately below the float come what we may call the motor members of the colony. These are bell-shaped, and by alternately opening and closing, draw in and expel the water from their cavities and thus propel the whole colony through the water. These motorists, like the central member which supports the whole, take no food, neither part in the production of the young; they have relegated these duties to other and specially qualified members. The capture and preparation of the food is undertaken by peculiarly modified members found beneath the swimming members. Scattered among the motorists are found numberless small oval individuals, each with a long slender thread. These threads are extremely sensitive, and by their means the members bearing them are enabled to undertake the duties of feeling and exploring for the colony. Lastly, there are the

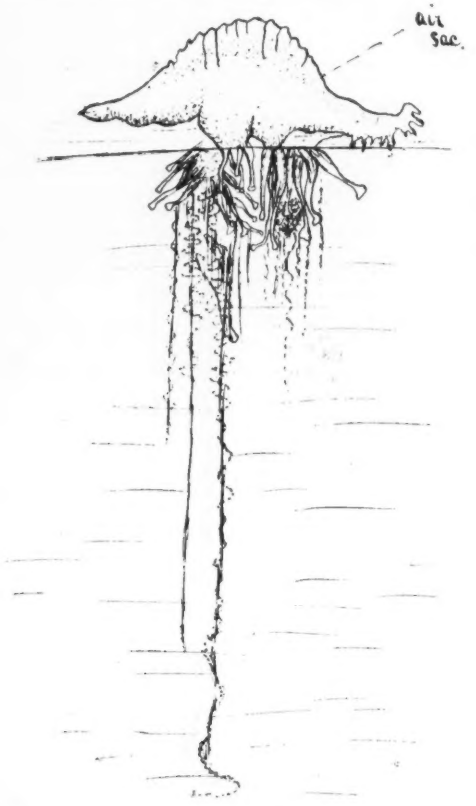


Fig. 2.—*Physalia*, the "Portuguese Man-o'-War," floating on the surface of the water.

individuals whose sole duty is to provide for the perpetuation of the species. And all these, as we have before remarked, are borne by a single member designed by the Fates, for the sake of the colony, to become a wind-bag.

The wonderful and dread "Portuguese man-o'-war" of the blue waters of the Mediterranean also proves, when examined, to be really a floating colony similar to that of *Physophora*. But the float or life-buoy in this case is much larger, taking the form of a pear-shaped bladder provided with a many-chambered crest or comb. If its duties are of the menial order, it has at least compensation therefor, inasmuch as it shimmers in the sunlight with the most gorgeous colouring, looking like molten silver tinted with light blue, violet, and purple, whilst the small thickenings in the comb are made conspicuous by vivid carmine. The long feelers may measure as much as 50 feet in length, and are vested with a stinging power which makes this creature more dreaded by the native than the shark.

Finally, we may mention certain Mollusca which have adopted the air-float for the purpose of supporting the eggs. Thus the beautiful oceanic violet sea-snail, Ianthina, throws out a long raft containing the eggs, which are carried along the surface of the water, where they may catch the sun and air. It is to be noted, however, that this float differs materially from those of all the others which we have examined, inasmuch as it is made by imprisoning bubbles of air in a gelatinous secretion, and not by the inflation of a pouch or wind-bag.

GIANT LAND-TORTOISES.

By R. Lydekker.

In the long-past days when the plains of India were the home of the mighty sivatherium and of still more gigantic elephants and mastodons, while its rivers were tenanted by hippopotamuses and huge long-snouted, gavial-like crocodiles, that country was likewise inhabited by the most gigantic land-tortoise of which we at present have any knowledge. When fragments of its fossilised shell and more or less nearly complete specimens of its limb-bone came under the notice of its original describers, it was thought, indeed, that they indicated a creature of truly colossal proportions, the length of the shell in a straight line being estimated at no less than twelve feet three inches. In a restoration of the shell made under the superintendence of the discoverers of the species, and still exhibited in the geological department of the Natural History Museum, the length was reduced to a little over eight feet. But even these reduced dimensions appear to be considerably in excess of the reality, and it is probable that the maximum length did not much exceed six feet. A shell of this size vastly exceeds, however, that of any modern land-tortoise, so that the Siwalik tortoise, or *Testudo atlas*, as it is scientifically called, is fully entitled to rank as the real giant of its kind.

But the Siwalik tortoise was by no means the only giant species inhabiting India during the Pliocene epoch, as remains of other, although smaller, forms have been discovered in the same deposits. The nearest living ally of the Siwalik species appears to be *Testudo emys*, of the countries east of the Bay of Bengal, in which the shell does not much exceed a foot in length. Both kinds have the front end of the lower shell produced and notched, although the production and notching are much more pronounced in the extinct form. Both also have the horny shield immediately above the tail double, instead of (as is usually the case) single; and in both the skin of the legs contained embedded nodules of bone.

The Pliocene deposits of the south of France have also yielded remains of a giant land-tortoise (*T. perpiniana*), with a shell about four feet in length, and likewise furnished with bony nodules in the skin of the limbs. And from the caves of Malta have been obtained bones of yet another very large species (*T. robusta*), apparently allied to the recently extinct *T. inepta* of Mauritius.

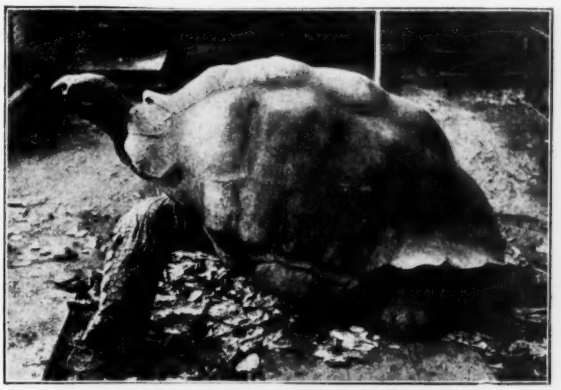
Going further afield, we find evidence of the existence

during late Tertiary times of giant land-tortoises in North America, while a few fragments of shell attest the former occurrence of another species in Patagonia. It may be therefore assumed that during the Pliocene, and, perhaps, a portion of the Miocene epoch, land-tortoises of huge size were spread over the greater portion of the warmer countries of the globe.

With, or before, the close of the Pliocene division of geological time, these great reptiles seem, however, to have utterly vanished from all the continents of the world, and to have continued to exist only in certain islands, from some of which they likewise disappeared before, or during the early portion of, the historic period, while others have become extinct quite recently. Whether these island giant tortoises are the direct descendants of the species which once inhabited the nearest continents, or whether they have been independently developed from smaller forms in or near their own habitats, is a question by no means easy to answer. Neither is it any less difficult to account for the complete disappearance (apparently without human intervention) of all the continental forms. Although the Siwalik mastodons, elephants, sivatheres, giraffes, hippopotamuses, and other large mammals, all died off, yet many of them left descendants (collateral or direct) in either India or Africa; and this makes it the more strange that not a single descendant of any of the Pliocene giant land-tortoises should have survived in any one of the five continents. Such, however, is the case, explain it how we may.

Since the Pliocene epoch, giant tortoises have been restricted to two widely-sundered groups of islands. In modern times the islands most famous for these tortoises are those of the Galapagos group, which take their title from one of the Spanish names (*galápago*) for a tortoise, and are situated on the equator, a comparatively short distance off the western coast of South America. All the other "tortoise-islands" are in the Indian Ocean, where they lie (with the exception of the lower extremity of Madagascar) within the southern tropic, off the African coast. By far the largest of these islands is Madagascar, which has long been inhabited by man, and from which the tortoises (perhaps in consequence of his occupation) disappeared long before the historic period, being known to us only by their sub-fossilised remains. Between the northern point of Madagascar and Africa lie the islands of the Comoro group, which had also native inhabitants of their own; and from these islands the tortoises likewise disappeared at an early date. All the other tortoise-islands in the Indian Ocean were inhabited. They include the Aldabra group, north-west of Madagascar, where the few tortoises now remaining in the south island are under Government protection, the Mascarenhas, or Mascarene group (Réunion, or Bourbon, Mauritius, and Rodriquez), the Amirantes, and the Seychelles. None of the Mascarene species survive in their proper home, and were long thought to be extinct, although a specimen has turned up from a distant island, to which it had been carried. Much the same may be said with regard to the Seychelle tortoises, which were exterminated long ago in their proper habitat. There seems, however, to be good reason for believing that a few survivors of the species have been preserved in islands to which they had been transported in ships. This transportation of tortoises from one island to another has indeed added considerably to the difficulty of unravelling the complicated history of the group; a specimen of the South Aldabra tortoise having been carried to one of the islands of the Chagos group, to the south of Maldives, whence it was subsequently transported to Mauritius.

The accounts left by the early voyagers show that in the Mascarene and other islands of the Indian Ocean, as well as in those of the Galapagos group, the tortoises formerly existed in enormous numbers. As regards the Galapagos islands, it is remarkable that there are no small-sized species; and the same holds good for the islands of the Indian Ocean, with the exception of Madagascar, where there is one comparatively small form (*T. radiata*). It should be added that, if we except Madagascar (where there is one moderate-sized carnivore), none of the tortoise-islands were ever the home of large and predatory mammals. This naturally suggests the idea that the survival in these islands of the reptiles under consideration is entirely due to the absence of such mammals. But, on the other hand, it has to be borne in mind that the giant Siwalik tortoise lived in a land where large mammals—both carnivorous and herbivorous—absolutely swarmed; and the same was also the case with the other extinct continental species referred to above. Moreover, we have no evidence of the existence of large tortoises on the continents of the world at an epoch before the advent of large mammals. Still, the absence of the latter from practically all the tortoise-islands is a fact that cannot be disregarded, and must almost certainly have had a very great influence on the development of their chelonian inhabitants.



Great South Aldabra Tortoise (*Testudo daudini*), from a specimen recently living in the London Zoological Gardens, and now preserved in the Museum at Tring.

In regard to the numbers in which giant tortoises formerly existed on the islands of the Indian Ocean, very few words must suffice. Writing in 1691, the French traveller François Leguat states that in Rodriquez the tortoises covered the ground so thickly that in places you might walk a hundred paces or more by stepping from the back of one on to that of another. In Mauritius, though apparently less abundant, they were still very numerous down to 1740; and there is ample testimony that during the seventeenth and eighteenth centuries they also swarmed on Réunion, although not a single specimen of the species indigenous to that island has been preserved. The ease with which these reptiles could be captured and carried off, and the facility with which they could be kept alive on board, coupled with the large amount of excellent meat yielded by each, rendered them a valuable food-supply to the crews of ships, and it was far from uncommon for vessels leaving Mauritius to carry off a cargo of four hundred at a time, while in 1759 one of four vessels specially engaged in carrying tortoises from Rodriquez to Mauritius took six thousand at once. Such a drain could not but tell rapidly on the supply, and by the early part of the last century the Mascarenes were denuded of their tortoise-fauna.

XUM

The Malagasy tortoise (*Testudo grandidieri*) appears, as already said, to have been exterminated before Europeans had any knowledge of the islands, but beautifully preserved shells (wanting the horny shields) have been discovered, three of which are exhibited in the Natural History Museum. Among the Mascarene tortoises, most of which are distinguished from those of Aldabra by their long thick necks and the absence of a nuchal shield * to the shell, five or six species are known in a sub-fossil state from Mauritius. To one of these (*T. indica*) special interest attaches from the circumstance that till about 1871 all the tortoises from the islands of the Indian Ocean were referred to by that name. Of equal interest, although from a totally different point of view, is the Rodriquez tortoise (*T. vosmæri*), on account of the extreme tenuity of its bony shell; a feature shared by certain of the Galapagos species, and indicative that the thick shell characteristic of tortoises generally is not required by the island forms which have no enemies.

A tortoise received in company with two others from the Seychelles in 1894 by Mr. Rothschild, and now living at Tring, is believed to be one of the Mascarene species, with which it agrees in the characters referred to above. It may have come from one of the smaller islands, and thus be different from any of the named forms, although it is difficult to determine this during its life. Very little appears to be known of the Réunion, Comoro, and Amirante tortoises, but it is stated by Mr. Rothschild that the one from Réunion differed from all the other Mascarene forms, and resembled those from Aldabra. Special interest attaches to the history of the surviving representatives of the presumed Seychelle tortoise, which has been named *T. sumeirei*. It appears that in the year 1766 five giant tortoises from the Seychelles were taken to Mauritius by the Chevalier Marion de Fresne, and have been since known as Marion's tortoises. In 1833 one, which died soon after, was brought to the London Zoological Gardens, where a second arrived some years later. A third was received in 1898, but did not long survive its journey. The other two are still living in Mauritius. By far the most celebrated of these latter is the one in the Royal Artillery Barracks at Port Louis. It is now nearly blind, although otherwise in good health. The shell measures about 40 inches in a straight line, and is reported to have been of that size so long ago as 1810. Probably this tortoise was at least a century old when first brought to Mauritius nearly 140 years ago. In its long thick neck, and the absence of a nuchal shield, *Testudo sumeirei* agrees with the Mascarene species, and as it is quite different from the Aldabra forms, Mr. Rothschild considers that its original home was the Seychelles, whence Marion brought his specimens—probably some of the last survivors of their kind—to Mauritius as curiosities. Possibly the tortoise brought in 1798 from the Seychelles to Colombo, where it survived till 1897, may have been of the same species. The length of its shell is 53½ inches, or only an inch-and-a-half less than that of the great South Aldabra tortoise noticed below.

Passing on to the Aldabra tortoises, distinguished by their short necks and the presence of a nuchal shield, we have first to notice that the only member of the group surviving in a wild state in its native habitat is the South Aldabra *Testudo daudini*. Very remarkable is the history of a male of this species received by Mr. Rothschild in 1897, which is the largest known example of modern giant tortoises, the length of the carapace in a straight line being no less than 55 inches, or only 19 inches short of the length assigned to that of the extinct *T. atlas*. This monster, whose original home was South Aldabra, lived for many years on Egmont Island, in the Chagos group, whence it was taken by its owner, Monsieur L. Antelme, to Mauritius, and thence sent to England. It is currently reported to have lived in Egmont for a century and a half, but since the Chagos group was only colonised from Mauritius in the early part of the last century, there is some doubt as to the correctness of the statement. Anyway, this tortoise must have been of a prodigious age at the time of its death. During its sojourn on Egmont Island this tortoise used to bury itself and become dormant for half the year—a most remarkable fact in a tropical island. South Aldabra is a coral island very difficult to traverse, so that it is no easy matter to obtain a sight of the tortoises. Seven were, however, captured and exported in 1895, of which six reached Europe alive.

The second species of Aldabra tortoise *(T. gigantea)* formerly inhabited the north and central islands in great abundance, but is now known solely by individuals introduced by the planters into the Seychelles, where they are kept in a state of semi-domestication, and by a single specimen in St. Helena. There appear to be two races of this species, namely the typical form, in which the shell is depressed, with the horny shields nearly smooth, and *T. gigantea elephantina*, in which the shell is highly convex, with the shields on the back marked by conspicuous concentric striations. In some instances the shield immediately above the tail is divided, as in the extinct Siwalik tortoise. The shell of a male of this species received by Mr. Rothschild in 1893 measured 40¼ inches in length (in a straight line) four years later. The St. Helena example is said to have lived in that island for more than a century. It is not a little remarkable that the survivors of the North Aldabra tortoise should have been preserved in the Seychelles, while those of the species believed to be indigenous to the latter islands have been kept in captivity in Mauritius.

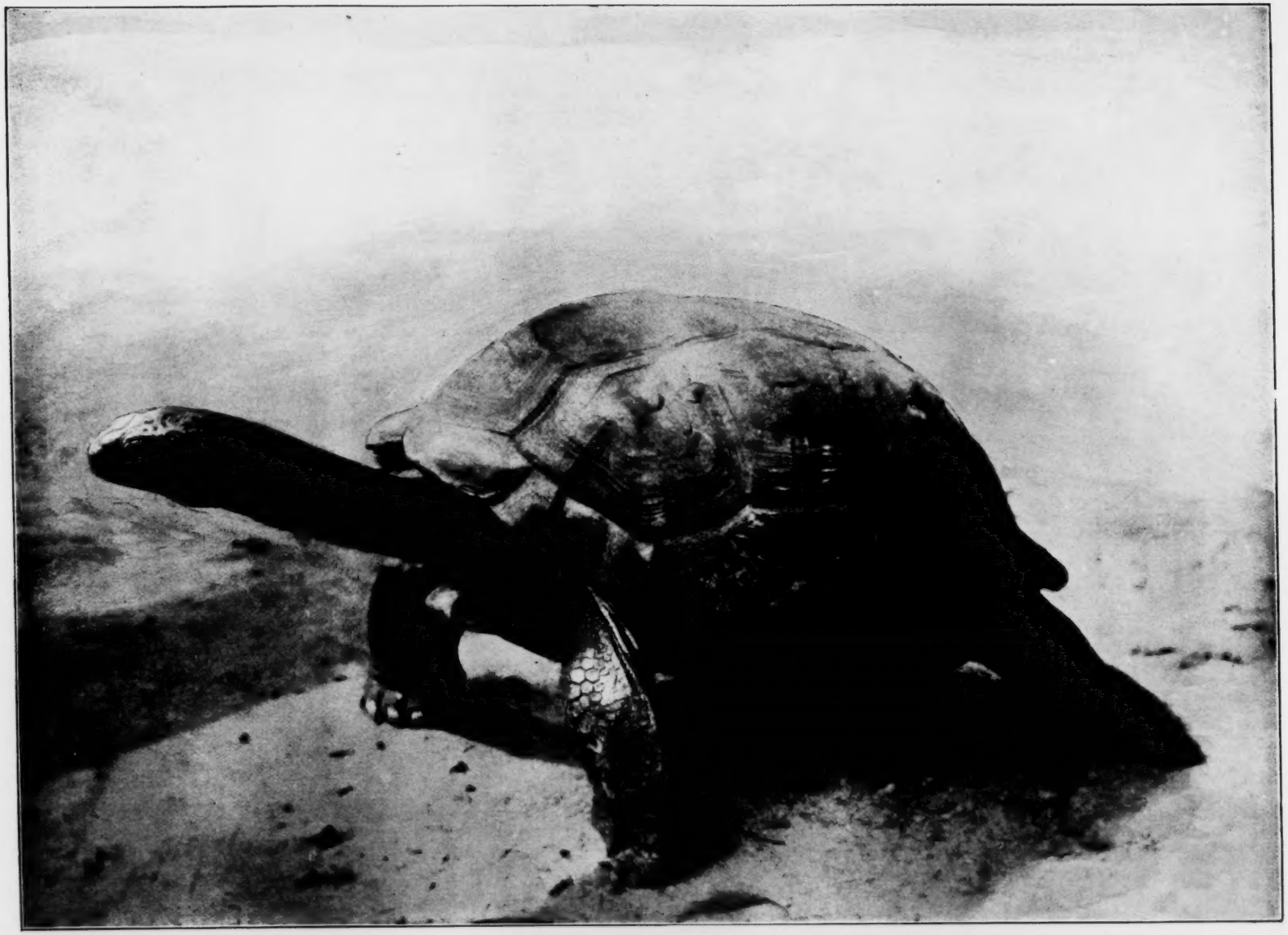
In 1894, Mr. Rothschild's specimen of the North Aldabra tortoise weighed 327 lbs., but by 1897 its weight had increased to 358 lbs. These weights are, however, vastly exceeded by that of the great South Aldabra tortoise which scaled no less than 560 lbs.; this was, however, immediately after its journey to England, during which it had become much emaciated, so that these figures afford no real criterion of its proper weight. Of the habits of the North Aldabra tortoise at Tring, its owner wrote as follows: "Whenever the temperature is over sixty (60° Fahr.), this tortoise has a fine run of 350 acres of grass park, but on the temperature falling to sixty, it is kept in a shed, and when once the temperature shows permanently below 58° Fahr., it is put in an orchid house, *i.e.*, from September to June. When at liberty in the park it lives entirely on grass, but in the hot-house feeds on carrots, cabbages, lettuce, and several other vegetables. It is very fond of rotten fruit."

Of the habits of the giant tortoises of the islands of the Indian Ocean in a state of nature we know practically nothing, owing to the fact that in South Aldabra alone are any members of the group living in a wild condition, and that accurate observation is there practically impossible. Of the mode of life of the Galapagos species we have comparatively full accounts; but limitations of space render it impossible on the present occasion to refer further to these species, either as regards their distinctive characteristics or their history and habits. I have only to add that readers of Knowledge are indebted to Mr. Rothschild for the loan of the photographs illustrating this article.

* The nuchal shield is the single symmetrical horny plate found in the middle line of the front margin of the shell of most tortoises.

XUM

XUM



THE GREAT MARION'S TORTOISE (*TESTUDO SUMEIREI*).
Now living at Port Louis, Mauritius.

XUM

XUM

MODERN COSMOGONIES.

By Agnes M. Clerke.

I.—THE NEBULAR HYPOTHESIS.

Immanuel Kant was, in 1751, still in the plastic stage. His period of "Pure Reason" was remote, and might have appeared improbable. Such as they were, his distinctions had been won in the field of concrete science, and the world of phenomena invited his speculations more seductively than the subtleties of logic. A seed was accordingly thrown into fertile soil by his reading of Thomas Wright's "New Theory of the Universe," as summarised in a Hamburg journal. It set him thinking, and his thoughts proved to be of the dynamic order. Wright regarded the heavens under a merely statical aspect. He laid down the first definite plan of their construction, showing that the stars were not aggregated at random, but by method, and this was much for one struggling item of humanity to have accomplished unaided. But the young philosopher of Königsberg could not rest satisfied with the idle contemplation of any subsisting arrangement. His mind was incapable of acquiescing in things simply as they presented themselves; it craved to know further how they came to stand to each other in just such mutual relations. He was, moreover, permeated with Epicurean doctrines. Not in any reprehensible sense. He could not be reproached either as a hedonist or as an atheist. His pleasures were intellectual, his morals austere, his convictions orthodox. Behind the veil of material existence he divined its supreme immaterial Originator, and his perception of the activity in Nature of an ordering First Cause remained equally vivid whether its disclosures were taken to be by immediate creation or through tedious processes of modification and growth. His large and luminous view embraced besides the ethical significance which such processes adumbrate. The following sentence shows an appreciation of the place of man in Nature truer and more profound than was attained perhaps by any other thinker in the eighteenth century:—"The cosmic evolution of Nature," he wrote in memorable words, "is continued in the historic development of humanity, and completed in the moral perfection of the individual."*

Nevertheless, he owned to a community of ideas with Democritus as to the origin of the universe. Lucretius had cast over him the spell of his lofty diction, and captured his scientific adhesion with the stately imagery of his verse. With reservations, however. Docile discipleship was not in his line. He availed himself, then, of the Democritean atoms, but by no means admitted their concourse to be fortuitous. Chaos itself, as he conceived it, half concealed, half revealed, the rough draft of a "perfect plan." His postulates were few. He demanded only a limitless waste of primordial matter, animated by no forces save those of gravitation and molecular repulsion, and undertook to produce from it a workable solar system. The attempt was no more than partially successful. Indeed, investigations thrown back into the fore-time lead, at the best, to precarious results, and this one, in particular, was vitiated by a fundamental error of principle. Its author clearly perceived that planetary circulation must be the outcome of a vortical swirl in the nebulous matrix; but he failed to see that no interaction of its constituent particles could have set this swirl going. Systems cannot, of themselves, add to their moment of momentum. External force should be applied to originate rotation in those naturally destitute of it. Now Kant was averse to employing arbitrary expedients, and he piqued himself on the simplicity of his postulates. Yet he need not have hesitated, had he only viewed things from the modern standpoint, to impart a wheeling movement to his colossal dust-cloud, as the upshot of the mode in which its materials might have come together from the four quarters of the universe; and he would thus have escaped stumbling at the threshold of his daring enquiry.

He supposed the particles forming the initial inchoate mass to fall together by gravity, but to be deviated from rectilinear courses through the effects of unequal resistance. And he derived from the combination of these multitudinous encounters a common axial rotation for the entire agglomeration. The futility, however, of this mode of procedure was adverted to by the late M. Faye in 1885.* The deviations in question would, in fact, exactly balance one another, there being no reason why movement in one sense should prevail over movement in the opposite; consequently, a general rotatory movement could not even begin to affect the seething mass, which would condense in sterile rigidity. Kant should then, as Laplace did, when his turn came, have assumed the gyration indispensable to his purpose. He asked too little from Nature; nor is the modesty of a demand other than a poor excuse for failure due to inadequacy of supply.

Kant made the germ of the future sun to consist in an aggregation of atoms at the core of the nebula, which, growing by successive, innumerable accretions, provided the motive power for the machinery of planetary construction. For it was, as we have seen, the jostling of the particles drawn towards the gradually preponderating centre of attraction which set on foot, it was supposed, the whirl eventually transformed into the tangential velocities of the sun's attendant bodies. They were formed, like the sun, by the perpetuation and increase of subordinate nuclei sure to arise in the elemental tumult. They were formed, not under the guidance of a definite law, but just where chance—or what seemed like chance—favoured an accretion. Nor could they have had a direct rotation.† Under the given conditions retrograde systems should have originated. This would have necessarily ensued from the incoherence of their materials. Particles revolving independently one of the others have smaller velocities the more remote they are from the focus of movement. Should they agglomerate into a globe, the inner ranges must, as being the swiftest, determine the direction of its rotation, which will consequently reverse the direction of its orbital revolution. Hence, it depends upon the nature of their generating stuff no less than upon the advance of central condensation, whether planets, in their domestic arrangements, contravene or obey the larger law of circulation prevailing in the system to which they belong; and Kant's nebula was undoubtedly such as to involve its contravention.

Yet his scheme, with all its deficiencies, bore the authentic stamp of genius—of genius imperfectly equipped with knowledge, but original, penetrative, divinatory. The very entitling of the work "A Natural History of the Heavens" was an audacity implying a radical change of conception. It was here that "island-universes" made their definitive appearance. Wright had indeed, five years previously (in 1750) thrown out the idea that "cloudy spots" might represent "external creations"; but as a mere vagary of the scientific imagination. Kant unhesitatingly laid hold of it; classed nebulæ as so many separate galaxies, and regarded them as combining with our own into a revolving system on a surpassing scale of grandeur. Kant was also the first to take into account

* Quoted by Dr. Hastie in the preface to his translation of Kant's "Cosmogony," Glasgow, 1900.

* "Sur l'Origine du Monde," 3e éd., p. 136.

† This also was pointed out by M. Faye, *loc. cit.*, p. 150.

the effects on their development of the plasticity of the heavenly bodies. He published in 1754, in a Königsberg paper, by way of preliminary to his forthcoming "Natural History," an outline of the workings of tidal friction in the earth-moon system. He saw clearly that it had acted in the past to reduce our satellite's rotation to its present minimum rate; and that it even now, by very slow degrees, tended to retard the spinning of the earth. This brilliant intuition remained unnoticed for well-nigh a century.

The assertion, however, that Kant's Cosmogony was an anticipatory "Meteoritic Hypothesis" lacks foundation. It is only true in the sense that his building-materials were pulverulent, not "fluid." Laplace's primitive nebula was a coherent mass. It rotated as a whole; it divided only under considerable strain; its separated parts showed concentrative power and individual unity. Kant's elemental matter, on the contrary, was a loose aggregate of independent particles, each pursuing its way, disturbed indeed by its neighbours, but essentially isolated from them. They were, in short, genuine Lucretian atoms, intended to stand for the ultimates of Nature, so far as such obscure entities could be evoked by fancy. The chaos that they formed was in nowise a "meteoritic plenum,' unless the phrase be emptied of all distinctive meaning. Meteorites, so far from being primordial units, have the show and semblance of advanced cosmical products. They raise special questions in chemistry, mineralogy, geology, and physics, claiming to be dealt with by experts in each branch. Before serving for explanatory purposes, in fact, they themselves need to be explained.

Laplace enounced his Hypothesis in 1796, and republished it with supplementary details in 1808. Herschel had meanwhile ascertained the retrograde movement of the Uranian satellite-system, a circumstance highly damaging to the validity of the adopted line of reasoning; yet its author was content to leave it in jeopardy. He must, to be sure, have regretted that Nature had seen fit to mar the admirable symmetry indicative of her presumed plan of action, running counter thereby to the plainest teachings of the doctrine of probabilities. But he kept his own counsel on the subject, preferring that it should be discussed, as it has been, by posterity; and posterity has, at any rate, learned that the seeming caprices of Nature are often more instructive than her most harmonious regularity, and has derived a warning from her frequent breaches of continuity against the undue extension of apparently well-grounded inferences.

Nevertheless, the constructive scheme handed on by the eighteenth to the nineteenth century has not, so far, been consigned to the Limbo of Vanities. It accorded too profoundly with undoubted realities to be thus summarily disposed of. No one then living had studied the mechanism of the solar system so attentively, or was so intimately acquainted with its workings, as Pierre Simon Laplace. None knew better how admirable, yet how far from inevitable were the adjustments by which its stability was secured. Long meditation upon their poise and plan persuaded him that the subsisting congruities of arrangement must have had their source in community of origin. He thus acquired the settled conviction that the sun engendered his cortège, or was together with it engendered from one parent-mass. And this virtually new truth (for Kant's speculation had attracted the minimum of notice) was set forth by him with a directness and lucidity which won for it an immediate place among the permanent acquisitions of the human intellect. Few perhaps any longer believe that planetary formation took the precise course laid down for it in the "Système du Monde"; but fewer still doubt that the entire ambit of the solar system was once occupied by an inchoate sun, and that its component bodies came into being incidentally to that sun's progressive contraction. In favour of this view Laplace could allege no clinching argument; it recommended itself to him solely through its inherent probability. Unexpected confirmation has, however, been afforded to it by the modern theorem of the conservation of energy, applied by Helmholtz with widely illuminative effect to solve the problem of the maintenance of solar heat. Laplace assumed an enormously high initial temperature. It was the only way open to him, and he took it. But a transcendentally hot nebula is not easily conceivable; an exalted thermal state seems, and probably is, incompatible with a high degree of attenuation. The key to the enigma was given by the demonstration that a diffuse mass, although actually cold, might contain vast stores of potential heat. There was then no need to postulate a primitive "fire-mist"; the surrendered energy of position amply sufficed to meet the requirements of the case. The temperature of the nebula necessarily rose as it contracted through gravitational stress; shrinkage and heat-evolution proceeded together; and they proceed together still. We live by the collapse of the sun. If its particles ceased to descend, their incandescence would quickly fail, and terrestrial vitality would become extinct.

Their number, however, being finite, the store of energy they can supply in falling, even from an infinite distance, is also finite. The process of solar sustentation is then terminable; it had a beginning, and it will assuredly come to an end. Now the *terminus ad quem* is of a calculable remoteness; it can be located within certain limits of time. But the *terminus à quo* depends upon too many conditions to be satisfactorily defined. It is only certain that the sun is to-day slightly more condensed than it was a year ago. It might, a few millenniums back, have been measurably larger, had modern micrometrical methods been available in the Stone Age; while, looking into the geological past, we discern a continually more diffuse globe, filling the orbit of Mercury when the earth was perhaps still red-hot, then successively ampler spheres, out to, and beyond that of Neptune. And here we are confronted with Laplace's nebula. The state of things he imagined results, accordingly, from two opposite modes of enquiry, by tracing forward the development of a tenuous rotating mass, and by pursuing backward the surely indicated, unceasing and inevitable distension of the sun. Hence, no sooner was it acknowledged that energy may be transformed, but cannot be destroyed, than the Nebular Cosmogony assumed a new and authoritative aspect.

Its scope, during the interim, had prodigiously widened. Five years before its promulgation at Paris, Herschel gave at Slough the first hint of a corresponding scheme of sidereal evolution. The discovery of a nebulous star in Taurus (N.G.C. 1514) set him pondering; and he found himself, as the upshot of his meditations, reduced to the dilemma either of concluding nucleus and *chevelure* to be alike stellar, though composed of stars differing enormously in real magnitude, or of admitting the possession by the star of a voluminous appendage constituted of a peculiar and unknown "shining fluid." He chose the latter alternative, adding the pregnant remark: "The shining fluid might exist independently of stars," and "seems more fit to produce a star by its condensation than to depend on the star for its existence."*

Thus tentatively, and under the compulsion of phenomena, rather than by the deliberate choice of its inventor, the universal theory of the genesis of stars from nebulæ took its rise. Herschel shaped it definitively in 1811 and 1814

* *Phil. Trans.*, Vol. LXXXI., p. 85.

into a formal rationale of celestial appearances, but in a large and general way. He made no attempt to realise the particularities of a process vaguely conceived of as one of growth by absorption or assimilation. He and Laplace thought out their separate schemes quite irrespectively one of the other. There is no evidence of their having met or corresponded, nor does their mutual influence appear to have been appreciable. Yet Laplace needed, as the raw material for his solar system, precisely the "shining fluid" elaborated, one might say, by Herschel, partly through the revelations of his telescopes, partly as the outcome of his reasonings concerning the *chevelure* of the star in Taurus. Halley, it is true, had by a sagacious intuition surmised the composition of nebulæ out of a "lucid medium." But the ineffectual phrase remained stranded in the pages of the *Philosophical Transactions*, and has only of late been set floating on the stream of scientific literature. Down to the end of the eighteenth century, world-building had been a purely speculative undertaking. It lacked actuality; it was concerned with operations thought of as belonging exclusively to a past order of things, now over and done with, and lying wholly outside the range of experience. Through Herschel's synthesis, however, those dimly apprehended operations were brought into view as variously progressing even now in different parts of the Cosmos, as incipient in some regions, advanced in others, the rubbish of the workshop here half masking the rising edifice, while elsewhere signs of decay and exhaustion give legible presage of an appointed end. And this stupendous vision of a forming universe has not vanished on critical scrutiny. It is no dream-tissue; it cannot dissolve into airy nothingness; it is based upon a firm substratum of reality. The immeasurable purposes of Creative Wisdom are still only in part fulfilled. It has become the strange privilege of humanity to contemplate, from its little shoal of time, the oceanic flow of their development. Thus, in the swing of the ages, Laplace's thought was caught up and vitalised. He himself was scarcely sensible of their movement. He recognised very imperfectly, if at all, his obligations to Herschel's nebulous star. His means were inadequate; his field of view narrow; his knowledge, though co-extensive with that of his time, fell short of what his boundless task demanded. In some respects his mode of procedure was faulty; his forecasts have been belied; the behaviour imputed by him to a nebula such as he devised is questionable, if not impossible. But, with the instinct of genius, he hit off the "psychological moment"; and, divining the genetic import of harmonies of construction obvious to perception, but arduous of interpretation, he laid down with masterly simplicity the ground-plan of a structure likely to maintain its substantial integrity despite innumerable additions and modifications.

THE PATH OF THE MOON.—II.

By A. C. D. CROMMELIN.

WE now pass on to the second part of the subject—viz., the more accurate study of the shape of the Moon's path round the Earth. If we suppose her to have been so projected as to describe a circle round the Earth in the plane of the ecliptic, then the Sun's disturbing action would distort this circle into an oval with its shorter axis in the direction of the Sun and its longer one at right angles to this direction. The diameters of the oval are as 69 to 70, which implies that the Moon is on the average 3400 miles nearer at syzygies (New or Full) than at quadrature. We can verify this by taking the Moon's Parallax at the 4 quarters for the "Nautical Almanac" for several years and taking the average value of each. Thus for the nine years 1883—1891 the average parallaxes are as follow—

New Moon 57′·62, Full Moon 57′·65, First and Last Quarter 56′·81.

This oval is known as the Variation curve, and in the researches on the Moon's motion commenced by Prof. Hill, and now being continued by Prof. E. W. Brown, it is taken as the starting point on which all the other disturbances are superposed. This method promises to give at once greater facility and greater accuracy in the study of the Moon's motion.

It will be noticed that the New Moon is slightly further away (about 120 miles) than the Full Moon. It is also found that the time from Last Quarter to First Quarter is (on the average of a large number of lunations) a quarter of an hour longer than that from First Quarter to Last Quarter. These are known as the Parallactic Inequalities in the Moon's distance and longitude, since they depend on the Sun's distance, and would disappear if this were sensibly infinite compared with the Moon's. The inequality in longitude can be determined observationally by observations near the First and Last Quarters, extending over many years, and the Sun's distance can be deduced from the result. Prof. Hansen, in this way, found that Encke's value of the Sun's distance ($95\frac{1}{2}$ millions of miles) was too great. Hansen, however, reduced it too much, his value being about $91\frac{3}{4}$ millions, instead of the now accepted value of 93 millions. The diagram (Fig. 3) gives an idea of the shape of the Variation curve; the departure from circularity, as also the slight displacement of the Earth from the centre of the oval, are very greatly exaggerated. The white circles indicate the position of the Mean Moon, while the black ones indicate that of the Moon affected by the Variation. If we leave the Parallactic Inequality out of consideration we see that the effect of the Variation on her direction vanishes at all 4 quarters, and reaches a maximum at the intermediate points or octants, where it amounts to $39\frac{1}{2}'$. At the first and fifth octant the Moon is in advance of the Mean Moon by this amount, while at the third and seventh it is the same amount behind it.

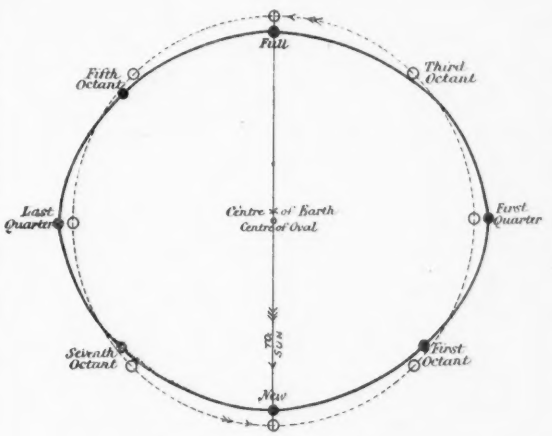


FIG 3.—The Variation Oval.

○ = Mean Moon. ● = Moon affected by variation.

The ancient astronomers trusted chiefly to eclipses for

the determination of the Moon's place, and consequently did not detect the Variation since the latter vanishes (as regards her direction) at both New and Full Moons.

The undisturbed path of the Moon round the Earth is not, however, a circle, but an ellipse with eccentricity $\frac{1}{18}$.

This produces the elliptic inequalities in her distance and direction. At perigee and apogee her direction is the same as that of the Mean Moon, but her distance is 13,200 miles less or greater than the mean distance, 238,818 miles. One quarter of a revolution after perigee she is at her mean distance, but $6^\circ\ 16\frac{1}{4}'$ in advance of the Mean Moon, while one quarter of a revolution before perigee she is an equal amount behind it.

The first effect of the Sun's action on this elliptic motion is to make the perigee move round the Earth in a period of 8·85 years, so that an anomalistic month (from perigee to perigee) is slightly longer than a sidereal one. But in addition to this continuous effect there is a periodic effect, known as the Evection, which produces a large oscillation, both in the eccentricity of her orbit and in the direction of her perigee. When perigee occurs at New or Full Moon the eccentricity rises from 0·055 to 0·066, while when perigee occurs at First or Last Quarter it falls to 0·044.

The perigee point has a mean annual motion of $40\frac{2}{3}^\circ$, but the Evection makes its motion oscillatory. At all the four quarters the directions of true and mean perigees coincide. When perigee occurs at the 1st or 5th octant (*vide* the "variation" diagram) the perigee point lags some 25° behind its mean position, while at the 3rd or 7th octant it is an equal amount ahead of it. At these times the eccentricity of the orbit has its mean value 0·055.

Owing to the Earth's orbit round the Sun not being circular, the disturbing action of the Sun on the Moon undergoes an annual variation. This produces the "annual equation" of the Moon's longitude; she is at her mean place about January 1st and July 1st, some 11′ behind it about April 1st, and an equal amount ahead of it about October 1st.

Some readers may be glad to have the means of computing with tolerable accuracy the Moon's longitude, latitude, and parallax for any epoch. Thus questions sometimes arise as to the date of New Moon in some distant year, or the position of the Moon after some battle or other historical event, and one has not always books of reference at hand to give the information. The notation in the following formulæ is that of Delaunay, but the numerical values of l, l', F, D, are due to Newcomb.

We first find the interval in days between the epoch required and 1900, January 1, Greenwich noon. This interval is called n, and is positive when the epoch is after 1900. We next calculate the values of l, l', F, D, from the following formulæ:—

l = Moon's Mean Anomaly = $309^\circ{\cdot}174 + 13^\circ{\cdot}064993\ n$.

l' = Sun's Mean Anomaly = $359^\circ{\cdot}465 + 0^\circ{\cdot}985600\ n$.

F = Moon's Mean Longitude measured from Asc. Node = $24^\circ{\cdot}482 + 13^\circ{\cdot}229351\ n$.

D = Difference of Mean Longitude of Moon and Sun = $2^\circ{\cdot}930 + 12^\circ{\cdot}190750\ n$.

Then the following formula gives us the Moon's Longitude:—

$$\begin{aligned}\text{Longitude} = {} & 283^\circ{\cdot}614 + 13^\circ{\cdot}176395\ n - 0^\circ{\cdot}186 \sin l' \\ & + 6^\circ{\cdot}289 \sin l \\ & + 0^\circ{\cdot}041 \sin (l - l') - 0^\circ{\cdot}030 \sin (l + l') + \\ & 0^\circ{\cdot}214 \sin 2\,l \\ & - 0^\circ{\cdot}114 \sin 2\,\mathrm{F} + 0^\circ{\cdot}658 \sin 2\,\mathrm{D} + 0^\circ{\cdot}046 \\ & \sin (2\,\mathrm{D} - l') \\ & + 0^\circ{\cdot}053 \sin (2\,\mathrm{D} + l) + 1^\circ{\cdot}274 \sin (2\,\mathrm{D} - l) \\ & + 0^\circ{\cdot}057 \sin (2\,\mathrm{D} - l - l') \\ & + 0^\circ{\cdot}059 \sin (2\,\mathrm{D} - 2\,l) - 0^\circ{\cdot}035 \sin \mathrm{D}.\end{aligned}$$

For the smaller terms a very rough computation of the angles will suffice. The error of the deduced longitude will seldom exceed 3′. For distant epochs we may apply the following correction to the longitude for secular acceleration (taken as 8″ per century).

Years before or after 1900.	Correction to Longitude.	Years before or after 1900.	Correction to Longitude.
	°		°
200	+ 0·01	1100	+ 0·27
300	+ 0·02	1200	+ 0·32
400	+ 0·04	1300	+ 0·37
500	+ 0·06	1400	+ 0·43
600	+ 0·08	1500	+ 0·50
700	+ 0·11	1600	+ 0·57
800	+ 0·14	1700	+ 0·64
900	+ 0·18	1800	+ 0·72
1000	+ 0·22	1900	+ 0·80

In the above equation the term with argument l' is the "annual equation," that with l the "elliptic inequality" with 2 F the "reduction," with 2 D the "variation," with 2 D − l the "Evection," with D the "Parallactic Inequality."

The Moon's Latitude = $5^\circ{\cdot}128$ sin. F + $0^\circ{\cdot}281$ sin. (F + l) − $0^\circ{\cdot}278$ sin. (F − l) + $0^\circ{\cdot}033$ sin. (2 D + F) + $0^\circ{\cdot}055$ sin. (2 D + F − l) + $0^\circ{\cdot}173$ sin. (2 D − F) + $0^\circ{\cdot}046$ sin. (2 D − F − l).

The formula for the Parallax is very simple; the following expression will give it to within a few seconds of arc:

Parallax = $57'{\cdot}04 + 3'{\cdot}11$ cos. $l + 0'{\cdot}17$ cos. $2\,l + 0'{\cdot}47$ cos. 2 D + $0'{\cdot}57$ cos. (2 D − l).

The semidiameter may be found by taking $\frac{3}{11}$ of the Parallax and then subtracting 1″.

The term in the latitude with argument 2 D − F is strikingly similar to the Evection. It has the effect of making the inclination of her orbit to the ecliptic a maximum (5° 18′) when New Moon or Full Moon occur at a node, while it is a minimum (5° 0′) when First or Last Quarter occurs at a node. Thus the inclination is at a maximum for all eclipses, and in consequence we get rather fewer eclipses than we otherwise should.

The motion of the node is also oscillatory as that of the perigee is, but to a much smaller extent. Thus the True Node coincides with the Mean Node when Nodal passage occurs at any of the 4 quarters; it is retrograding at double the Mean rate when the node is passed at quadrature, while it practically stands still when the node is passed at syzygies.

When the node is passed at the 1st or 5th octant the longitude of the True Node is some 2° less than that of the Mean Node, while at the 3rd or 7th octant it is an equal amount greater than it.

The method of expressing the perturbations as the sums of series of sines and cosines of uniformly varying angles is that which is employed in all the lunar and planetary tables. When such tables have once been constructed, the computation of the place of the Moon or planet at any time is merely a matter of simple arithmetic.

In the above description of the Moon's True path round the Earth, no attempt has been made to explain the reason of the various inequalities; it is not indeed easy to get far in the theory of the subject without the use of analytical methods. But in a difficult problem like the Lunar Theory I believe the best method is to commence with an accurate arithmetical conception of the nature of the Moon's motion, after which theoretical researches can be pursued with much greater interest and facility.

Letter.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

DID THE ROMANS KNOW ALUMINIUM?

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The origin of the legend (*see* KNOWLEDGE, September, 1902, p. 203) which may lead us to suppose that the Romans may have known aluminium is to be traced to a passage of Petronius' "Satyricon," Chapter LI., (1) of which the following is a translation:—

"However, a workman succeeded in making a cup of a kind of glass which could not be broken. Admitted to the presence of the Emperor, he presented it to him, then, begging to have it handed back to him, he threw it down on the stone floor. The Emperor could not help shuddering, but the workman picked it up all dented, as would have been the case if made of bronze, took out a small hammer from his pocket, and, without being in the least concerned, thoroughly repaired the damage. After this, he already thought himself on Jupiter's throne, especially when he heard himself being asked: 'Is there any man acquainted with thy process? Think.' 'No one.' The Emperor thereupon ordered his head to be cut off, for if the thing once got to be known, gold and sand would have the same value for us."

Petronius' account was written about A.D. 60. Pliny the Elder (2) (Hist. Naturalis I. XXXVI., c. 26) succinctly records it, perhaps after Petronius, without seeming to give it very much credit. His text dates from A.D. 75.

According to Dion Cassius (3), Roman History (written about A.D. 220) (R.R. lib. LVII., c. 21), the anecdote would be posterior to A.D. 22.

Isidorus of Sevilla (4), who lived in the VIIth century of the Christian era, and who is known especially for his "Etymologies," relates Petronius' account, while somewhat modifying it.

In his book of Etymologies (16th book, chap. 16), the following is in effect to be found:—

"It is said that under the reign of Tiberius a workman had invented a vitreous combination (*vitri temperamentum*) which was flexible and ductile."

He then recounts substantially the same anecdote as that I have quoted from Petronius.

To sum up, the anecdote which may give occasion to suppose that aluminium was known in the time of the Romans must date from about A.D. 25 (according to Dion Cassius) at Rome.

We know it:—

1st. From Petronius' Sat. 51 (about A.D. 60), a picturesque anecdote.

2nd. From Pliny the Elder, H. N. XXXVI., 26 (about A.D. 75), a mere mention.

3rd. From Dion Cassius, H. Rom. 57, 21 (about A.D. 220), a mere mention.

4th. From Isidorus of Sevilla, Etym. XVI., 15, 6 (about A.D. 600), an anecdote similar to that of Petronius.

With the exception of the last of these accounts, it is clearly a question of an "unbreakable glass"; and, in fact, Petronius' anecdote has been attributed to the manufacture of annealed glass.

If we refer to the passage in Petronius, we will notice that the author has put the account into Trymalcion's mouth, following upon another account about the origin of the Corinthian bronze, which is evidently absurd. In fact, Petronius wanted to make Trymalcion appear ridiculous, and his commentators (Panckouke Translation) point out that the legend of ductile glass was a tale of antiquity which no longer found any belief at the beginning of the Christian era.

And now we can ask ourselves the question—supposing the anecdote related by Petronius is serious—in what manner could Tiberius' workman have obtained aluminium?

A few years after the discovery of aluminium, a memorandum from M. Chapelle appeared in the Reports of the Academy of Sciences, tending to prove that by heating a mixture of chloride of sodium, clay, and charcoal, a multitude of metallic globules are obtained, which would be aluminium.

Good Isidorus of Sevilla, who after his account gives such an ingenuous note, will not accuse us of being naive if we say that, given its origin, this note may be taken seriously.

In the course of work which has led me to obtain blue glasses with base of chromium, I had occasion to make an interesting experiment. In a paper which the "Berichte der Deutsche Chemische Gesellschaft" (1898) have inserted in its entirety, and to which the "Chemical News" (5) (Vol. 78, No. 2021, 1898) has likewise given ample hospitality, I have published the following experiment:—

I have heated in a fireclay crucible lined with charcoal a mixture of borax and alumina with a small quantity of dichromate of potassium and a quantity of silica equal to a two-fifth part of the alumina used, a metallic pellicle was formed, consisting for the most part of aluminium.

It is well known that boric acid is plentiful in Italy, since for a long time the greatest part of the borax delivered for the purposes of industry came from the lagoons of Tuscany. Therefore, it is not impossible that the three bodies—boric acid, potassium, clay—which under the influence of charcoal, perhaps favoured by small quantities of foreign substances, may give aluminium, might have been brought together.

However, I have not, any more than Tiberius' workman, the pretension of having obtained pure aluminium by this process; but it appears to me interesting to compare this result of an experiment, which interested a few chemists at the time I made it known, with the question raised by your correspondent.

At any rate, the question deserved to be asked, and here the legend is indeed of more worth than many well established truths, since it leads one to make curious experiments; as for me, I am indebted to it for the discovery of the reduction of alumina by aluminium, as well as that of the extraordinarily energetic combustion of a mixture of water and pulverised aluminium, which is set alight by means of a little dry powdered magnesium.

A. DUBOIN,
Docteur ès-Sciences Physiques, Maître de Conférences à la Faculté des Sciences de Grenoble.

Obituary.

SIR GEORGE STOKES.

BY the death on February 1st of Sir George Gabriel Stokes this country lost one of the most eminent men of science that it has ever possessed, and the greatest mathematician of the day.

He was born on August 13th, 1819, at Skreen, Co. Sligo, his parents being the Rev. Gabriel Stokes, the Rector of the parish, and Elizabeth, daughter of the Rev. John Haughton, Rector of Kilrea. When thirteen years of age he was sent to Dublin to be educated at the school of the Rev. R. H. Wahl, D.D., from which he passed in 1835 to Bristol College. At the age of eighteen he entered Pembroke College, Cambridge, where in 1841 he graduated as Senior Wrangler and First Smith's Prizeman. He became Fellow

XUM

of his College in the same year, and held the Fellowship until 1857, when he vacated it on his marriage to Mary, daughter of the Rev. T. R. Robinson, D.D., Director of Armagh Observatory. He was reinstated in the Fellowship when the new statutes of the College rendered this possible. He was appointed in 1849 Lucasian Professor of Mathematics in the University of Cambridge, the chair held one hundred and eighty years earlier by Sir Isaac Newton. He was elected Fellow of the Royal Society in 1851, became its Secretary in 1854, and its President from 1885 to 1890. From this Society he received the Rumford and the Copley Medal; the former in 1852 in recognition of his investigations regarding the refrangibility of light, the latter in 1893. In 1869 he presided over the British Association at its meeting in Exeter. He was elected as one of the Members for the University in Parliament from 1887 to 1892, and was created a baronet in 1889.

The above brief list may serve to give some little idea of the honours to which he so deservedly attained. Of the work which he performed it is impossible to give any adequate idea; it can only be fully appreciated by those to whom he had been as intellectual parent. We can, perhaps, best summarize his scientific career and work in the concluding words of an article written by Prof. J. J. Thompson for the *Cambridge Review* of 1899, June 1st, in connection with the celebration of the Jubilee of Sir George Stokes as Lucasian Professor:—"By his researches on hydrodynamics he has founded a new branch of the science; in optics he has, to use the words of Lord Kelvin, been the teacher and guide of his contemporaries; he was the first to enunciate in his lectures the principles on which spectrum analysis is founded; he unravelled the laws of fluorescence; he investigated the variation of gravity over the surface of the earth; he solved problems of the greatest difficulty in pure mathematics; whilst the latest of his long series of researches is his remarkable paper on the nature of Röntgen rays. His papers are the classics of science; they are remarkable, not only for the results obtained, but also for their perfect clearness of expression and thought, for the elegance of the mathematical methods, for their maturity of judgment, and for that care and finish on which so much of the impressiveness of a paper depends.

These researches show the combination of supreme mathematical and experimental power; with simple apparatus and without the appliances which are now at the command of physicists, he has made experiments which have settled some of the most crucial points in optics, and which will be quoted as long as science exists. The rooms in Pembroke, where he made many of his experiments, will in the history of science and of the University be associated with those in the old court of Trinity, where Newton made the prism reveal the nature of white light. And, indeed, there are many points of resemblance between the careers of Newton and of Stokes: both held the Lucasian Professorship, both were Presidents of the Royal Society, both represented the University in Parliament; and the resemblance is not confined to the offices they held, it extends to their type of mind. Often, in reading Stokes's papers, we feel this is just how Newton would have treated this point, these are the deductions which Newton would have drawn."

Notes.

Entomological.—Prof. W. N. Wheeler continues his studies of North American ants, that have been previously mentioned in these columns. In the *American Naturalist*, Vol. XXXVI., 1892, pp. 88-100, he describes *Psyonomyrmex imberbiculus*, a new "Agricultural" Ant, from Texas. Incidentally he refutes the popular and widely-diffused notion that some ants of this genus cultivate a particular kind of grass—the "ant rice"—protecting, weeding, and reaping their crops. These ants feed largely on grass seeds, and when some of the seeds that they have brought into their minute storehouses sprout so far as to become unfit for food, the ants carry them out to a kind of rubbish heap, which often forms a circle around their nests. These seeds may then germinate and grow up, forming an imperfect ring of grass, but, as Prof. Wheeler remarks, to state that the ants "sow this cereal for the sake of garnering its grain, is as absurd as to say that the family cook is planting an orchard when some of the peach stones which she has carelessly thrown into the back-yard chance to grow into peach trees."—G. H. C.

Geographical.—Dr. Carl Lumholtz, who spent five years, between 1890 and 1898, in North-western Mexico, recently read a very interesting paper on his explorations and researches before the Royal Geographical Society (*see* the *Geographical Journal*, February, 1903). Dr. Lumholtz lived for a considerable time alone with various Indian tribes in the western Sierra Madre. Dr. Lumholtz's ethnological researches and collections are of great interest and importance. Speaking of the endurance of the members of a tribe called the Tarahumare, the author mentions that these people will easily run one hundred and seventy miles without stopping. They have regular races as a test of endurance rather than speed. As a proof of their insensibility to pain, Dr. Lumholtz once witnessed twenty-three hairs pulled out in one stroke from the head of a sleeping child, who merely scratched its head a little and slept on. Many of the Indians of the Sierra Madre are very musical, and Dr. Lumholtz, who has learned their songs, gave examples of them in the course of his paper. Most of these tribes are deeply religious, and Dr. Lumholtz has studied particularly their symbolism. Every little detail and ornament bears not only a religious significance, but often forms an actual prayer. The author referred to certain species of cacti, which are worshipped by two tribes of Indians, a regular cult being instituted, whose main purpose is to promote the health of the tribe as well as to bring rain. The plant is supposed to talk and sing, and to feel joy and pain. It has great exhilarating properties, and allays all feelings of hunger and thirst, and does away with all exhaustion. It also produces colour-visions. A great feast, elaborate and lengthy preparations for which are made, is held at certain times, at which the plant is eaten. The main feature of the feast is a peculiar kind of dancing by men and women, whose faces are painted with various designs with a symbolic meaning.

Zoological.—The Society for the Protection of Birds held a very successful and well-attended annual meeting on February 10th, under the chairmanship of the Duke of Bedford. During the year 1902 the Society made distinct advances in several directions. A short Bill, framed by the Committee of the Society, was passed through the Houses of Parliament. It provides for the confiscation of any bird unlawfully killed or captured, or any egg unlawfully taken. Formerly the specimens illegally secured were often of more value than the fine imposed. The Society may be congratulated, too, on having been the means of inducing the authorities in British India to prohibit the exportation of bird skins and feathers (except ostrich feathers and *bonâ fide* specimens "illustrative of natural history") from that country. The Society are doing good work, too, in encouraging the young to take an intelligent interest in bird-life.

Our knowledge of the vertebrate zoology of Egypt has been largely augmented by the appearance of the handsome and splendidly illustrated volume on the Mammalia by the late Dr. J. Anderson and Mr. W. E. de Winton. The manuscript was left in a forward, although incomplete, state at the death of the author, and to Mr. de Winton was assigned the task of revising, completing, and preparing it for press. How great and how difficult has been his share of the task, only those who have been to some extent behind the scenes are in a position to fully realise. Needless to say these difficulties have been overcome, and the work in its present form will long remain the standard authority on the subject. Thanks to the practice of issuing "preliminary notes," no new species, and only a single new race are named in the volume. Many revisions in nomenclature, for all of which Mr. de Winton seems to be responsible, are, however, made, and must apparently be adopted by future writers. The beauty and number of the coloured plates form a special feature of the work. The thanks of all naturalists are due to Mrs. Anderson for having arranged that the labours of her late husband should not be lost to the world.

Much interest attaches to the description, by Professor J. C. Ewart of Edinburgh, of a breed of pony from Iceland, the Faroes, and some of the Western Hebrides, characterised by the absence of callosities on the hind-legs and the sparse hairing of the base of the tail. The colour is yellow-dun, with black points, a dark stripe down the back, and traces of striping on the face and limbs. This breed, for which the name *Equus caballus celticus* (why "Celtic"?) is proposed, is regarded by its describer as the descendant of the horse domesticated by the inhabitants of Western Europe during the palæolithic age. Prof. Ewart also discusses the nature of the callosities, or warts, on the limbs of the horse-tribe, and comes to the conclusion that they are remnants of foot-pads, and have nothing to do with glands. He even goes so far as to correlate the fore-callosity with the supplemental pad on the fore-foot of a dog, while the hinder pair he identifies with the posterior pad on the foot of the Australian banded anteater (*Myrmecobius*).

We are glad to learn that Mr. de Winton has been appointed Acting Superintendent of the Zoological Society's Gardens, Regent's Park, in the room of Mr. C. Bartlett, retired. Mr. de Winton has already commenced operations on the unsightly bank by the canal where the Japanese and some other deer were formerly kept, and the work promises to be a great improvement. The deer have been removed to more suitable enclosures. Doubtless other alterations will be undertaken when time and other circumstances permit.

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

THE MIGRATIONS OF THE FIELDFARE.—Attention has been drawn in the columns of KNOWLEDGE, from time to time, to Mr. W. Eagle Clarke's valuable work on the migrations of British birds. At the 1902 meeting of the British Association the Bird Migration Committee's report consisted of summaries by Mr. Clarke of the migratory movements of the Fieldfare and the Lapwing. In former summaries (viz., those of the migrations of the Song Thrush, White Wagtail, Syklark and Swallow) the lighthouse returns for the years of the special enquiry (1880-1887), supplemented by records published in various journals, formed the chief material upon which his conclusions were based, but last year Mr. Clarke made use of additional records obtained from the south coast light stations, while he himself spent a month at the Eddystone Lighthouse. The following is a brief abstract of Mr. Clarke's summary of the migrations of the Fieldfare as observed in the British Islands. I hope next month to give similar particulars of those of the Lapwing.

The FIELDFARES which visit the British Islands breed in Norway and Sweden, and there is no evidence to show that any individuals from the small colonies in various parts of Central Europe come to our shores. Compared to those of the Song Thrush the British migrations of this species are simple, and are typical of (1) a winter visitor to our islands from north-western Europe, and (2) of a bird of passage *en route* from and to its northern summer home and southern winter-quarters. There are in addition local winter movements due to climatic conditions.

Autumn immigrations.—The Fieldfare seldom quits its summer home until October. There are annual arrivals of comparatively small numbers in the prior half of October, but the first of the great autumnal immigrations is not to be expected until after the middle of the month. They continue to arrive until mid-November. The main immigration is on the east coast. In some seasons the birds arrive by a series of pronounced movements, while in others a single "rush" is recorded. These great immigrations often extend from the Shetlands to the Wash. When only a single "rush" has been recorded, it has been followed or preceded by (or both) a steady influx covering the ordinary period of the autumnal incoming. After their arrival on the coast the Fieldfares soon find their way to accustomed winter quarters, including those in the western districts. A migration of lesser extent passes down the west coast of Scotland, the Outer Hebridean branch of this stream reaching the north of Ireland. These western movements are not performed simultaneously with those on the east coast, and the birds probably reach and pass down our Atlantic seaboard by an overland route. The Fieldfares, however, which regularly travel south by way of the Outer Hebrides seem to reach that far western route by way of the Faroes—a remarkable fact because these birds are not found in Iceland.

Autumn Passage and Emigration.—An autumn passage to winter quarters beyond the British Isles is chiefly observed on our east coast, and immediately follows the immigrations of the latter half of October and the first half of November. A number of the immigrants observed on the west coast also proceed southwards.

Winter Movements and Emigration.—On the advent of snow and cold the Fieldfares quit the higher grounds and seek the lowlands, the coast and the south. In seasons of exceptional cold, vast numbers of Fieldfares, in company with other birds, pass southwards, as well as westwards, to Devon and Cornwall, and also many cross the Channel to south-western Europe. But, unlike some other birds, they do not cross St. George's Channel to Ireland from the south-east. These migrations depend entirely upon the weather. A small number of Fieldfares winter in Southern Scandinavia, and sometimes some of these are driven southwards and appear in Shetland and Orkney.

Spring Immigration from the South.—Towards the end of March, throughout April, and sometimes down to the early days of May, the Fieldfares which have wintered in or retreated to countries south of Great Britain return northwards.

Spring Passage and Emigration.—The departure northwards of the Fieldfares which have wintered with us and of those birds of passage just mentioned does not commence until early in April, and generally lasts until the first week in May, but is sometimes prolonged into the middle of

XUM

that month. The earliest appear to leave in small parties either alone or with other species, but those that follow late in April and in May leave the east coast in great flocks and in company with many other emigrants. There are also important emigrations on the west coast, and chiefly in Scotland, which receives the Irish birds *en route* for the north. This western passage proceeds throughout April and lasts until mid-May, but no great general flights are witnessed. There is also much overland emigration from western districts to the east coast performed throughout Great Britain.

Before proceeding to the coast for departure, Fieldfares assemble and form flocks in the various districts in which they have wintered, and are very noisy and restless for several days before they finally quit their winter haunts.

This species is extremely wary, and is less frequently killed or captured at the lanterns of the light stations than any of its congeners.

BREEDING OF THE RED-NECKED PHALAROPE IN IRELAND.—An event of very great interest to students of British birds is recorded by Mr. Edward Williams in the *Irish Naturalist* for February, 1903 (pp. 41-45). Mr. Williams proves beyond doubt that the Red-necked Phalarope breeds and has bred for some years at all events in the west of Ireland. He thinks it best to keep the exact locality secret, which is a very wise precaution, since those who make the vain boast of having British-taken eggs are usually most unscrupulous as to how they obtain them. Except for one example shot in November, 1891, and a doubtfully authentic one in 1902, the Red-necked Phalarope was unknown even to visit Ireland until last July, when Mr. Williams received some specimens to stuff from a gentleman in the west of Ireland, who wrote "The birds breed here, and have, according to my keeper, done so for many years." In August the same correspondent sent a chick as incontrovertible proof of this fact, and wrote "During my tramp through the bog I counted seventeen (Red-necked Phalaropes), but there may have been many more; the most of the birds I saw were females. . . . I am surprised that these little chicks are able to survive their many enemies, especially as there are a lot of Black-backed and other Gulls on the bog." The Red-necked Phalarope breeds chiefly in the arctic regions, of both the Old and the New world, but it still nests also in the Shetlands, Orkneys, and Outer Hebrides, but in very greatly reduced numbers. The present discovery of its breeding in Ireland is a most interesting southward extension of its known breeding range. Many ornithologists recognise that there is still much to be discovered in Ireland, but comparatively few have worked there, and it is to be hoped that this startling discovery may be the cause of a closer observation of birds in Ireland.

Notices of Books.

"JENA GLASS AND ITS SCIENTIFIC AND INDUSTRIAL APPLICATIONS." By Dr. H. Hovestadt. Translated and Edited by Prof. J. D. Everett, F.R.S., and Alice Everett. Pp. 419. (Macmillan.) 15s. net.—This translation of Dr. Hovestadt's history of the Jena glass industry, and the properties of Jena glass, is of importance if only to show those unfamiliar with the German language what German patience and scientific system has accomplished in one direction. In 1876 Abbe directed attention to the demands of science for better optical glasses, and discussed the requirements which should be satisfied. Five years later, Schott, who was interested in glass making, commenced with him an investigation of the directions in which improvements could be made, and, as the result of their labours, the first trade catalogue of the Jena Glass Laboratory was issued in 1886. This, however, was only the beginning of the industry. Experiments were still carried on, and, in addition to the six usual elements of glass, twenty-eight new ones were introduced by degrees in order to discover their effects. It was soon seen that by the introduction of new elements variation of the hitherto fixed relation between refraction and dispersion could be obtained. Boric acid was found to lengthen the red end of the spectrum relatively to the blue, while fluorine, potassium, and sodium produced the opposite effect. So the work went on, covering all the stages of manufacture until each one was understood and could be controlled. The first price list from the Jena Glass Works contained forty-four optical glasses, of which nineteen were of essentially new composition. In 1888 a supplement was issued containing twenty-four additional glasses, of which thirteen were new, and in 1892 another supplement contained eight more glasses, six of them being new. From the scientific side alone the results of these investigations are of deep interest, and commercially they have been the means of developing a most successful industry. In the volume under notice the physical and chemical properties of the various types of Jena glass are discussed, and the scientific and industrial applications indicated. The translators have done their work admirably, so that the text reads easily and not at all like a translation from the German. Moreover, in several places the argument has been simplified, and brief explanations have been interpolated where considered necessary. The book can thus be commended to the notice of opticians and students of optics generally.

"A HISTORY OF HINDU CHEMISTRY." By Prof. Praphulla Chandra Rāy, D.Sc. Vol. I. Pp. lxxix. + 176 + 41. (Williams & Norgate.) 12s. 6d. net. Illustrated.—There is a large amount of very interesting matter in this book, which traces the history of Hindu chemistry from the earliest times to the middle of the sixteenth century A.D., with Sanskrit texts, variants, translation and illustrations. A few references to alchemy occur in the Atharva-veda, in which gold is regarded as the elixir of life, while lead is considered as the dispeller of sorcery. In the alchemy of the West, lead, as is well known, is associated not with beneficent, but with gloomy influences. Prof. Ray recognises four periods in the history of chemistry in India; they are (1) the Ayurvdic Period, from the pre-Buddistic Era to about 800 A.D.; (2) the Transitional Period, from about 800 A.D. to about 1100 A.D.; (3) the Tantric Period, from 1100 A.D. to about 1300 A.D.; (4) the Iatro-Chemical Period, from 1300 A.D. to about 1550 A.D. He shows that in ancient India the useful arts and sciences, as distinguished from mere handicrafts, were cultivated by the higher classes. The priests then followed various professions, but when the Brahmins reasserted their supremacy on the decline or the expulsion of Buddhism all this was changed. The caste system was established in a rigid form, and a priestly class was set up, which discouraged the experimental study of medicine and other sciences. The effect is graphically described by Professor Rāy. "The intellectual portion of the community being thus withdrawn from active participation in the arts, the *how* and *why* of phenomena—the co-ordination of cause and effect—were lost sight of, the spirit of inquiry gradually died out among a nation naturally prone to speculation and metaphysical subtleties, and India for once bade adieu to experimental and inductive sciences." It will be evident from this brief mention of a few points that Professor Rāy's book is an important contribution to scientific literature, and students of the history of science will be glad that such an instructive selection from the records of Hindu chemistry is now available

"ZITTEL'S TEXT-BOOK OF PALÆONTOLOGY." Translated by C. R. Eastman and others. Vol. II. (Macmillan. 1902.) Pp. viii. + 283. Illustrated. Price 10s. net.—More than two years have elapsed since the appearance of the first volume of this translation (dealing with the Invertebrata), but in spite of the fact that during that period many important discoveries and advances have been made in palæontology, the text of the present volume departs less widely from the original than was the case with its predecessor. And it cannot be denied that, in the main, this adherence to the original lines is an advantage, for it must be confessed that some of the amendments made in the first volume (notably in the case of the Mollusca) can hardly be regarded as improvements. Nevertheless, there are instances where a slavish adherence to the original plan is not to be commended; this being notably the case with regard to the classification of the fishes, where Dr. Smith Woodward (who is responsible for

this section of the translation) has, against his own convictions, retained the division of the "Teleostomi" into the discredited Ganoids and Teleosts.

The present volume includes all the vertebrates save mammals, which latter are to constitute the third and final volume. As already said, Dr. Smith Woodward, the greatest living authority on the subject, has undertaken the translation and revision of the chapters on fossil fishes. Dr. E. C. Case, of Wisconsin, has done the same for the amphibians, and has collaborated with other authorities in the reptilian section of the work. For the birds, Mr. F. A. Lucas, of the U.S. Museum, is responsible.

As a whole, we have nothing but commendation for this volume, which displays on every page full evidence of the care and attention bestowed on its preparation by the translators. Although the figures are much less numerous than in the large edition of Zittel, they are amply sufficient for the needs of the ordinary student; and the descriptions of the genera and larger groups are concise and not over-loaded with detail. So far as we can see, the work (save for certain details of classification, to one of which allusion has been made above) is thoroughly up to date, and therefore a safe guide to the student.

Space does not admit of any attempt at detailed criticism, but it may be mentioned that the translators follow the original in classing the leathery turtle in the same subordinal group as the ordinary turtles—a course in which we think they are fully justified by the facts. On the other hand, we cannot agree with Mr. Lucas that *Palapteryx* is the proper name for the elephant-footed moa; neither do we like the use of the name Theromorpha for the extinct anomodont reptiles. But these are details. As a whole, the book seems singularly free from misprints and other typographical errors, but we notice that in the figure of the quadrate of *Mosasaurus*, on p. 155, there is no indication in the legend as to the part of the skeleton to which the specimen belongs. The low price of this excellent volume renders it within the means of almost every student.

BOOKS RECEIVED.

Life and Letters of Thomas Henry Huxley. By his Son, Leonard Huxley. (Macmillan.) In three volumes. 12s. net.

Real Things in Nature. By Edward S. Holden, SC.D., LL.D. (Macmillan.) Illustrated. 3s. 6d.

In the Andamans and Nicobars. By C. Boden Kloss. (Murray.) Illustrated. 21s. net.

Nature Student's Note Book. By the Rev. Canon Steward, M.A., and Alice E. Mitchell. (Constable.) 2s. net.

Nature Studies (Plant Life). By G. F. Scott Elliot, M.A., B.SC., F.L.S., F.R.G.S. (Blackie.) Illustrated. 3s. 6d.

Teaching of Modern Languages in Schools and Colleges. By D. T. Holmes, B.A. (Paisley: Alexander Gardner.)

Bromide Printing. By Rev. F. C. Lambert, M.A. (Hazell, Watson & Viney.) Illustrated. 1s. net.

Enlargements: Their Production and Finish. By G. Rodwell Smith. (Hazell, Watson & Viney.) Illustrated. 1s. net.

Experiments on Animals. By Stephen Paget. (Murray.) 6s.

What Star is it? Tablets for identifying Unknown Stars. By Herbert W. Harvey. (Spottiswoode & Co., Ld.) 1s. net.

Theoretical Geometry for Beginners. By C. H. Allcock. (Macmillan.) 1s. 6d.

Practical Exercises in Light. By Reginald S. Clay, B.A., D.SC., (Macmillan.) 2s. 6d.

Geometry. By S. O. Andrew, M.A. (Murray.) 2s.

Design of Dynamos. By Silvanus P. Thompson, D.SC., F.R.S. (Spon.) Illustrated. 12s. net.

Practical Exercises in Geometry. By W. D. Eggar, M.A. (Macmillan.) 2s. 6d.

Spirals in Nature and Art. By Theodore Andrea Cook, M.A., F.S.A. (Murray.) Illustrated. 7s. 6d. net.

Religion for all Mankind. By Rev. Charles Voysey, B.A. (Longmans.) 2s. 6d. net.

The Old Testament: In the Light of the Historical Records of Assyria and Babylonia. By T. G. Pinches, LL.D., M.R.A.S. (S. P. C. K.) 7s. 6d.

Scene of our Lord's Life. By R. Waddy Moss, D.D. (Hodder & Stoughton.) 1s.

On the Avifauna of the Outer Hebrides, 1888-1902. By J. A. Harvie-Brown, F.R.S.E., F.Z.S. (Reprinted from the *Annals of Scottish Natural History.*) (Edinburgh: David Douglas.)

South-Eastern Naturalist for 1902. (Stock.) 2s. 6d. net.

British South Africa Co.—Report upon the Present Condition of Rhodesia. By J. F Jones, C.M.G.

Fire Brigade Reform. By Capt. Shean. (Fisher Unwin.) 6d.

List of Second-Hand Instruments. C. Baker, 244, High Holborn, W.C.

Catalogue of Fine Art Photographs. Erdmann & Schanz, 116, Leighton Terrace, Bedford Hill, Balham, S.W.

FAMILIAR BRITISH WILD FLOWERS AND THEIR ALLIES.

By R. LLOYD PRAEGER, B.A.

II.—THE ROSE FAMILY.*

THE *Rosaceæ*, although their flowers are so different in appearance from those of the *Leguminosæ* (which were briefly dealt with in my last article), are nevertheless closely related to them, and may naturally be considered after them. The Rose family forms a tolerably large group of plants, differing widely in appearance, and while they are conveniently grouped together in one Natural Order, they nevertheless embrace several sections so well marked that these have often been treated as separate Orders. The *Rosaceæ* number over a thousand species—trees, shrubs, and herbs—which are distributed all over the world, but are, in the main, plants of the temperate regions of the Northern Hemisphere. The most striking feature of the Order is the fleshy fruits possessed by many of them, which, by cultivation, yield us the greater number of our native fruits. Equally famous is the wonderful range of beautiful blossoms that have been produced by cultivation of certain species of the typical genus of the Order, *Rosa*. Various parts of a large number of plants of the Order possess medicinal properties. The bark and root of many are astringent, owing to the presence of tannin. More well-known is the presence of prussic acid in the sub-orders *Drupaceæ* (Plums, &c.) and *Pomaceæ* (Apples and Pears). This violent poison has so powerful a taste and odour, that a minute quantity is immediately recognizable, as we may notice especially in the Bitter Almond. It is present in the seeds of most members of these sub-orders, and often also in the leaves, as in the common Cherry Laurel (*Prunus Lauro-cerasus*), which contains enough prussic acid to kill in a short time insects which are enclosed with a few crushed leaves.

Let us briefly review the various sub-orders into which *Rosaceæ* may be divided. *Chrysobalaneæ* are the only group which is not represented in the British Islands. These are tropical and sub-tropical trees and shrubs, found both in the Old and New World. Most of them have stone-fruits; to this section belongs the Cocoa Plum (*Chrysobalanus Icaco*) of the West Indies. *Pruneæ* is a group of much economic importance, including as it does many well-known stone-fruits, such as Almond, Peach, Nectarine, Plum, Damson, Apricot and Cherry. Here belong also the Cherry Laurel and Portuguese Laurel of our shrubberies. This is essentially a North-Temperate group of trees and shrubs. *Spiræaceæ* are also chiefly North-Temperate. The Meadow-Sweet (*Spiræa Ulmaria*), which will serve as a type, has a fruit very different from those of the last group, consisting of a little ring of twisted follicles. *Spiræa* is the

FIG. 1.—Fruit of the Meadow-Sweet (*Spiræa Ulmaria*). Half natural size.

* For the use of the figures illustrating this Article, the writer expresses his obligation to Messrs. C. Griffin & Co. They are taken from his "Open-Air Studies in Botany."

best known genus of the sub-order, and includes a number of shrubs and herbs that are grown in gardens for the sake of their graceful foliage and pretty clusters of white or red flowers. The *Dryadeæ* derive their name from the genus *Dryas*, of which one species belongs to our country—the beautiful little alpine plant *D. octopetala*, or Mountain Avens. Here also belongs the genus *Potentilla*, famed for the number of beautiful herbaceous species which it includes. The best known genera, however, are *Fragaria* and *Rubus*, the former of which yields the luscious Strawberry, the latter the Raspberry and Blackberry. In most of the other species the fruit is quite dry. *Poterieæ* forms a curious degraded group of *Rosaceæ*, with flowers strangely different from those, such as Dog Rose, Apple Blossom, Hawthorn, or Bramble, which we associate with the Order. The gay cup-shaped corolla which gives beauty and character to the flower of most of the *Rosaceæ*, is in many plants of this group entirely suppressed. The *Poterieæ* are like several of the preceding groups found chiefly in the North-Temperate zone, but its largest genus, *Cliffortia*, is characteristically South African. The sub-order *Roseæ* includes only the genus *Rosa*. The glorious array of cultivated Roses are the offspring of a few wild foreign species, notably *R. centifolia*, *R. gallica*, *R. alba*, *R. indica*, *R. bengalensis*; and the British *R. arvensis* (Trailing Dog Rose), and *R. rubiginosa* (Sweet Briar.) The Roses are essentially a North-Temperate group, a few extending southward into the tropics, but none reaching the South-Temperate regions. Lastly there is the sub-order *Pomaceæ*, so called from the characteristic fleshy fruit or *pome*, which is borne by its members, such as the Apple and Pear. Sometimes the fruit is stony, as in the Hawthorn, but more frequently coriaceous, as is found in the Quince, Pear and Apple.

Let us now consider the British species of *Rosaceæ*, and note their number, distribution, and the various points of interest connected with them. There is a difficulty in stating the total number of British species, owing to the varying value that has by different botanists been allowed to the puzzling series of Brambles, to which may be added the Roses. Thus while Hooker *(Student's Flora)* reduces the British species to 45, by lumping the fruticose Brambles under *Rubus fruticosus*, L., and treating certain other segrates similarly, the *London Catalogue* lists over 150 species, by allowing specific rank to a large number of Brambles and other segregates. The British *Rosaceæ* are, speaking very generally, herbs, shrubs, or small trees with a wide distribution, with graceful forms and pretty fragrant flowers, white and yellow being the prevailing tints. Of the sub-order *Pruneæ*, we have the genus *Prunus* alone, represented by several species, The tough black-stemmed Blackthorn or Sloe *(P. spinosa)* with its thorny branches and bitter fruit, is well known. The closely allied *P. insititia* (Bullace), and *P. domestica* (Wild Plum) are more plum-like small trees, and doubtfully indigenous. Then we have three species of Cherry. *P. Cerasus* (Dwarf Cherry) has bitter red fruit, and the larger *P. Avium* (the common Wild Cherry) has also bitter fruit, which is red or black. The latter is the origin of our many garden Cherries. The Bird Cherry (*P. Padus*) bears its pretty blossoms, not in umbel-like clusters like the last two, but in graceful racemes. The fruit is small, black, and bitter. Of the three Cherries, *P. Cerasus* alone has a restricted range in our islands, being distinctly southern.

The *Spiræaceæ* are, like the *Pruneæ*, represented in these countries by only one genus, *Spiræa*, which numbers but two native species. The delightful Meadow-Sweet (*S. Ulmaria*) needs no description. Its bold growth, its striking foliage, deep green above, white beneath, with deeply-cut pinnæ and curious little leaflets between, and its cloudy masses of creamy fragrant flowers, are one of the dearest features of our English meadows. The other native species, the Dropwort (*S. Filipendula*), is an equally pretty, though less striking plant, with beautifully cut pinnate leaves and white flowers. The roots bear peculiar conspicuous knobs. While in Great Britain it is widely spread, it has in Ireland a peculiar limited range, occurring in great abundance over a small portion of Clare and Galway, and there only.

Turning to the *Dryadeæ*, we find ourselves face to face with the bewildering Brambles. We can easily discriminate the Raspberry (*Rubus Idæus*) with its pinnate leaves and red fruit. Its stems are upright and covered with weak prickles, and it does not attempt to climb. Then we have two herbaceous species, also easily recognized—the Stone Bramble (*R. saxatilis*), with far-creeping slender barren stems and short upright flowering ones, which eventually bear red fruit; and the small Alpine Cloud-berry (*R. Chamæmorus*), with entire Lady's-mantle-like leaves and orange fruit. And then remains the Blackberry group. These are interesting to us as being good examples of "hook-climbers." Their stems are furnished with very strong hooked prickles—remarkable structures, arising, like hairs, from the skin, not from the wood, as do, for instance, the thorns of the Hawthorn. By aid of these prickles, the Brambles support themselves amid tangled thickets, and may be often seen bursting into blossom 10 or 15 feet up in the air. It is interesting to note that the long arching stems in autumn, when their growth is nearly over, frequently again seek the ground,

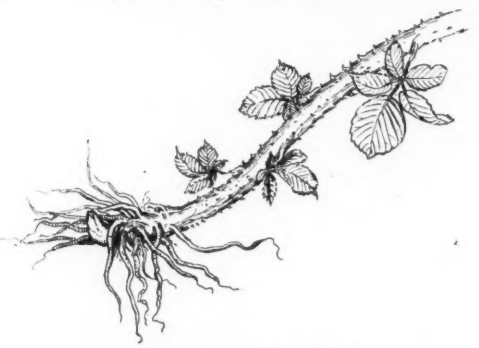


Fig. 2.—Rooted tip of Bramble-shoot.

and their tips root themselves firmly in the soil. Next year the shoot produces flower and fruit, and dies. But from the rooted tip proceeds a fresh plant, which in turn loops away and produces new offspring far from the parent. The plant may in this manner travel forward at the rate of 20 feet or more per year, and may cross obstacles such as a ten-foot wall in a single season.* These Brambles were grouped by Linnæus under one species (*Rubus fruticosus*). But when we look into them, great differences are noticeable as regards growth, habit, colour, texture, shape, and size of leaf and flower; and in the form, number, and arrangement of prickles. Hence numerous other names have been bestowed on apparently distinct forms, and the process has gone on until the latest work on the British Brambles lists one hundred "species" under Linnæus' *R. fruticosus*, with numerous sub-species and varieties. It is difficult to explain such a complicated tangle of closely allied forms. The most nearly related genera, such as *Potentilla*, display no

* See *Irish Naturalist*, March, 1897, and February, 1902.

such puzzling series among their species. Apparently, in *Rubus* the innate power of variation is being exercised to a high degree, and could we look forward, we might expect to find that by a further divergence along the present lines of variation, and a suppression of the intermediates, a group of well-marked species might ultimately arise from *Rubus fruticosus*.

Closely allied to *Rubus* is *Fragaria*, the Strawberry, as valuable to us as the Raspberry on account of its delicious fruit. The difference in the appearance of the fruit of these two genera is due to the fact that whereas in the Raspberry the edible fruit is formed by a number of soft juicy carpels set on a comparatively hard receptacle, in the Strawberry the carpels are dry, and the receptacle on which they are set swells up and becomes sweet, juicy, and coloured. The little Wood Strawberry (*F. vesca*) is our only native species. The luscious fruit of our gardens is due to the cultivation of the Hautbois Strawberry (*F. elatior*), a plant chiefly of eastern Europe. The well-known and pretty Potentillas come next in order. Including *Sibbaldia*, *Tormentilla*, and *Comarum*, which are sometimes reckoned distinct genera, the British species number twelve, all but one perennial herbs. Many of these are familar wild-flowers—the favourite Silverweed (*P. Anserina*), the Creeping Cinquefoil (*P. reptans*), the Tormentil (*P. Tormentilla*), all with yellow flowers, and the Strawberry-like *P. Fragariastrum*, which has white blossoms. The Marsh Cinquefoil (*P. palustris*) is easily recognised by its upright stems, pinnate leaves, and dull red-brown flowers. Among the rarer species are the Shrubby Cinquefoil (*P. fruticosa*), a small bushy gregarious shrub, looking in the distance like low Gorse. It is a very local plant, occurring in the North of England and the West of Ireland. *P. Sibbaldi* is a little Scotch alpine, with minute yellow flowers. *P. alpestris* is also alpine, with more conspicuous yellow blossoms. The rarest British species is *P. rupestris*, a comparatively tall plant with pinnate leaves and white flowers, found on limestone rocks in Montgomeryshire. *Dryas* has but one British species, the delightful *D. octopetala*, a far-creeping prostrate shrub covering mountain rocks with a sheet of dark-green shining leaves, white underneath, from among which rise singly the large white blossoms, which give way to clusters of feathery fruits, each achene being furnished with a long awn—the only instance among British *Rosaceæ* of a fruit adapted for wind-dispersal. Of *Geum*, or Avens, we have two species. *G. urbanum* is a common wayside plant, growing a couple of feet in height. Its fruits are furnished with long hooked points (the persistent styles) which easily attach themselves to the wool of passing animals, and thus secure for the seeds a wide dispersal. *G. rivale*, the Water Avens, is generally like the last, but has larger drooping reddish flowers, which do not open widely.

Turning now to the *Potericæ*. Three British genera belong here:—*Poterium*, *Alchemilla*, and *Agrimonia*. The two species of *Poterium*, *P. officinale* (Greater Burnet) and *P. Sanguisorba* (Lesser Burnet) are well-known English wild-flowers. Both have pretty pinnate leaves, from among which rise slender stems bearing dense egg-shaped heads of small flowers, which are dark purple in the former, greenish or purplish in the latter. If the flowers be examined, they will be found to be destitute of corolla. Four coloured pointed calyx-segments take the place of petals. In *P. Sanguisorba*, moreover, the flowers are made male or female by the suppression of one or other set of essential organs. Both plants are wind-fertilised, and have the elevated dense inflorescence, inconspicuous blossoms, and conspicuous stamens and pistils, characteristic of such plants. *Alchemilla* supplies us with several pretty herbs. The common Lady's-mantle (*A. vulgaris*), with fan-like leaves and golden-green flowers is well known; and the little *A. alpina*, frequent on our higher mountains, is justly a favourite in gardens. It is the beautiful silkiness of the under-side of the leaves that forms its most pleasing character. *A. arvensis* (Parsley Piert), is a quaint little annual, common in cultivated ground, with inconspicuous green flowers. In *Alchemilla*, as in *Poterium*, the corolla is absent, but the eight-parted calyx, of which each alternate segment is smaller than its neighbour, gives the appearance of a four-parted calyx, and a four-parted green corolla. In *Agrimonia*, alone of our *Potericæ*, a corolla is present. The flowers of the Agrimony, borne in long spikes, have yellow petals. The fruit of Agrimony is interesting, being furnished round the top with a ring of hooked bristles, which like the hooked styles of *Geum*, assist seed-dispersal by becoming entangled in the hair of passing animals—or in one's stockings. *Agrimonia Eupatoria*, the common Agrimony, is a well-known roadside wild-flower. *A. odorata* is very similar, but larger and with more spreading fruit-bristles.

Fig. 3.—Alpine Lady's-mantle (*Alchemilla alpina*). Half natural size.

The *Roseæ*, which consist of the genus *Rosa*, are distinguished by their fruit, in which the numerous dry nuts are enclosed by the calyx-tube, which becomes fleshy and coloured, giving the appearance, in botanical parlance, of an *inferior* fruit. The Roses are prickly shrubs, usually climbing by means of their hooked prickles. The species are found chiefly in North-Temperate regions. The genus resembles *Rubus* in possessing many forms which approach too close to each other to be satisfactorily treated as species. The number of Roses in our country may be variously estimated at 7 to 13, according to the amount of "splitting" which we are prepared to indulge in. All have large and showy flowers, and are among the most delightful features of our English hedge-rows. To attempt to discriminate the various species in an article of this kind would be futile. The most easily distinguished are the little Burnet Rose (*R. spinosissima*), perhaps the most deliciously fragrant of our species, and the Trailing Rose (*R. arvensis*), whose large white blossoms are almost scentless.

To come finally to the *Pomaceæ*. Here belong the genera *Pyrus* (Apple and Pear), *Cratægus* (Hawthorn), and *Cotoneaster*. Of *Pyrus*, the best known species is *P. Malus*, the Crab-Apple, from which the many kinds of cultivated apple are derived. The variety *acerba*, which is truly native with us, is a more picturesque shrub, both as regards flower and foliage, than var. *mitis*, which, though equally common, is believed to have always a garden origin. The Wild Pear (*P. communis*) is, like the last, doubtfully native, though found often in wild ground. Of several other species of *Pyrus*, the most familiar is the Mountain Ash (*P. Aucuparia*), which alone of British species possesses pinnate leaves. The White Beam (*P. Aria*), with egg-shaped serrate leaves, white and felty on the under-side, is also a familiar tree. Turning to the

XUM

genus *Cratægus*, our only species, the Hawthorn, needs no description. In this genus the seeds are enclosed in a bony case, instead of in cartilaginous cells as in *Pyrus*. The remarkable thorns which render the plant so formidable are the attenuated terminations of the branches. They resemble in this respect the prickles of the Gorse, and have a quite different origin from the prickles of the Bramble or Rose. The function of the Hawthorn spines is undoubtedly protective. The last genus of *Pomaceæ*, *Cotoneaster*, has, like *Cratægus*, but a single British species, and this is confined to a single locality—*C. vulgaris*, which grows, though now nearly extinct owing to the incursions of thoughtless collectors, on Great Orme's Head. It is a small shrub, with ovate leaves, pink flowers, and red berry-like fruit.

Conducted by M. I. Cross.

NOTES ON THE COLLECTION, EXAMINATION AND MOUNTING OF MOSSES AND LIVERWORTS.

By T. H. Russell.

(Continued from page 45.)

Before dealing in detail with the subject of mounting, let me add a few words with reference to registering slides and specimens, &c. My plan has been to have one general register of slides, in which the various mounts are entered consecutively as completed. Each page is ruled in five columns, headed respectively, "Number," "Date when gathered," "Name," "Habitat, &c.," and "Remarks." The label on the slide, in addition to briefly recording the name, locality, and date, bears the number corresponding with the entry in the Register, and this number is also marked on the packet containing some spare material for future use, if required. I also have a copy of the "London Catalogue of British Mosses and Hepaticæ" (a work, by the way, of which we are badly in want of a new edition, that of 1881 having been long since exhausted), which has been inter-leaved, the numbers in the "Catalogue" corresponding with the names of the various plants being repeated on the added pages. Opposite to each of these numbers I write the numbers of the slides in my collection referring to the particular plant in question. Thus, *Bryum alpinum* is numbered 337 in the "Catalogue," and against this number I find entered "105, 719," which gives me the references to the two slides of this species in my collection. By the help of these two registers I can always find the slides I possess of any particular moss, and also the details of place and time where and when it was found. I have another register, which is divided into columns (two to a page), each of which is numbered and named in correspondence with the "London Catalogue," and there I can enter a short note of any moss I may meet with but which I do not wish to mount. Lastly, I have a small book in which I record the medium used for mounting and sealing each slide. with the date of each of these operations. I have found the above registers extremely useful, and if entered up systematically they really give very little trouble.

II.—Mounting.

Owing to their small size and the facility with which their original freshness can be revived, as already noticed, mosses can be far more satisfactorily preserved than is possible with ordinary flowering plants. The greater number may be readily mounted on the ordinary glass slips, and in this form they not only occupy a comparatively small storage space, but remain, for all practical purposes, as fresh as when they were gathered. I have specimens in my collection now that were put up twenty years and more ago, and which have altered little in appearance in the meantime.

I have tried several materials and compounds for mounting purposes, but unhesitatingly give the palm to glycerine jelly, both on account of the facility with which it may be manipulated, and by reason of its admirable preservative powers. I have for many years made my own jelly according to the following receipt, which is a slight variation on that given in Carpenter's work on "The Microscope." Take 2 ounces (by weight) of "invalid" gelatine, 6 ounces of water and 6 of glycerine. Soak the gelatine in the water until it swells (this takes about 40 minutes), then place the vessel containing the gelatine and water (a jam-pot is very serviceable; it should be provided with a cover of some kind) in a saucepan of water, and boil over a slow fire until the gelatine melts. When the gelatine is cool, but still liquid, add the white of one egg, and mix well. Boil the gelatine, as before, until it becomes thick with the coagulated albumen—this takes about half an hour; add the glycerine and 25 or 30 drops of carbolic acid and mix well; strain through filter-paper before the fire, and a clear pale yellow jelly should be the result.

I propose to describe my ordinary process of mounting with this medium. The specimen to be mounted must first be cleansed from all earth and grit in water, and the spores and air gently expelled from any capsules by means of the dissecting needles; it must then be left to soak for at least 24 hours in a mixture composed of water 1½ ounces, rectified spirit 1½ ounces, and glycerine 5 drachms; the small china pans in which moist water colours are sold are very useful for this purpose. When the specimen is taken from this preparatory liquid in readiness for mounting care must be taken to remove the fluid adhering to it as far as possible; this may be done by placing it on a glass slip, and tilting this so as to allow the superfluous liquid to drain off, and then, last thing, applying blotting-paper.

A hot-water bath is essential for mounting with glycerine jelly; mine consists of a small glass tumbler, provided with a closely-fitting tin cap or lid. A piece is cut out of this lid at the margin, leaving a space just wide and large enough to admit the neck of a small glass bottle containing the jelly; this bottle can thus hang in the hot water in the tumbler, when the lid is in place, by means of its lip, which rests on the top of the tin cover, and in this way the jelly is kept melted, and is, moreover, close at hand for use. When my mounting is likely to take long I wrap a piece of flannel round the tumbler in order to retain the heat in the water as long as possible. The glass slip on which the mount is to be made, as also the cover-glass, must be first carefully cleaned in water; acetic acid is useful for removing all traces of grease, and nothing serves better for drying the glasses than an old, soft cambric handkerchief. The glass slip is placed upon the flat tin cover of the hot-water bath, and the specimen, after being freed from the preparatory fluid, is laid on it. A few drops of the liquid jelly are then taken from the bottle by means of a small glass pipette, and are dropped on to the specimen. While the jelly is kept liquid by the heat of the water-bath all air-bubbles must be carefully removed with the dissecting needle, and here the binocular dissecting microscope will be found most helpful. Too much care cannot be taken in this somewhat tedious process, as the success of the slide practically depends upon the thoroughness with which it is carried out.

Nothing detracts more from the appearance of a mount when viewed under the microscope than the presence of these disfiguring silvery globes, lurking among the delicate leaves, or perhaps entangled in the teeth of the peristome, and my own rule always is that, rather than allow a serious blemish of this kind, the slide must be sacrificed, or the mount be recommenced. I have found it a great help in many cases, especially when an object likely to retain air, or an undue amount of the preparatory fluid is in hand—as, for instance, a large empty capsule, or a plant with the leaves closely covering the stem—to put it into a little jelly on a spare glass slip, and then to extract the air as far as possible before transferring it to the slip on which it is to be mounted. The whole plant thus becomes more or less saturated with the melted jelly, and the air-bubbles cannot find their way back to the mount, as they are apt to do if the whole process is carried out on the one slide. A second hot-water bath is not unfrequently of much assistance.

When everything has been prepared, and the specimen is in place, immersed in plenty of the liquid jelly, the cover-glass is taken up with the forceps, and gently lowered on to the jelly, beginning from the left-hand side, driving the jelly (and too often, alas, the specimen also) before it as it is allowed gradually to fall into place. This is an operation of no little delicacy, as if great care is not taken a large bubble of air will make its way in at the last moment. If, as frequently happens, the putting on of the cover-glass has caused a displacement of the object, this must be rectified before the jelly is allowed to set, and here the bent dissecting-needles will be of great service, as a considerable amount of re-arrangement can be effected with one of them, and stray air-bubbles may also be removed without disturbing the cover-glass. The slide is now taken from the bath and allowed to cool, and in a few minutes the jelly will have so far solidified that the mount can be examined under the microscope, when, should any serious defect be disclosed, the jelly must be re-melted, and the shortcoming be rectified. The final process consists in removing the superfluous jelly from around the cover-glass with a knife, cleaning the slide from all trace of the jelly, a handkerchief moistened at the lips is the most efficient method, and sealing the cover-glass round the margin with some kind of varnish. I have tried a good many sealing materials, and, on the whole, much prefer copal varnish, as sold by artists' colourmen, thinned with a little benzine. One special advantage arising from its use is that if any portion of the object happens to be fixed near to the edge of the cover-glass, it can nevertheless be seen through the practically colourless varnish. I may add that I usually mount two cells on each slide; in the larger of them I place a small portion of the moss, together with a few capsules, if possible in various stages of growth, and two or three perichœtial leaves, while the other cell contains some leaves dissected from the plant (where of importance from both stem and branch), and a few pieces cut from the mouth of the capsule to show the peristome.

(To be continued.)

MONOCHROMATIC LIGHT.—The use of light filters or screens has of late become increasingly appreciated, and numerous attempts have been made to secure a light filter of definite value, which shall pass a maximum quantity of light. A fresh interest has been added to the subject by the method of obtaining monochromatic light which was exhibited by Dr. E. J. Spitta at a recent meeting of the Royal Microscopical Society.

It has to be remembered that strictly monochromatic light—that is, a selected ray of the spectrum of one uniform wave length—cannot be secured by light filters only. All the manufactured screens are only approximately monochromatic—that is, by the judicious selection of ingredients they absorb certain undesirable colours.

Practical monochromatism can, however, be secured with a suitable arrangement of prisms, and this, undoubtedly, is the most precise method of working. It is not possible, however, with the majority of workers for prisms to be brought into regular use, and a recapitulation of the best screens that are known will be of interest.

In passing, the advantages of light screens or filters may be indicated. In the first place the possibility of a lens to divide fine detail is in a measure increased. Mr. Nelson has stated that monochromatic blue light increases the effective working of objectives of low aperture 14 per cent., but beyond ·90 N.A. the value in this connection is not worth consideration, but it is of special value in producing a clearer image of the specimen under examination.

In effect, if a light of shorter wave length than that possessed by white light be used for illuminating purposes, whether obtained by prisms or screens, the effective aperture of a lens is increased. A reference to a numerical aperture table will show this at once, the lines per inch resolvable by blue light being considerably in excess of those resolvable by white light with identically the same lens.

(To be continued.)

DISSECTING NEEDLES.—A dissecting needle of suitable shape is often of great convenience. The following brief note may be of interest. If it is desired to bend it, it should be heated to a dull red and allowed to cool gradually, it can then be bent into any shape, and if desired an edge can be ground or filed. To re-harden, heat as before to blood-red heat, and plunge into cold water. In this condition it will be found too hard and liable to easily break. It should be rubbed bright on fine emery paper, then held in a spirit lamp until it assumes a pale straw colour, and again dipped into cold water. The correct temper for use will then be obtained.

PRACTICAL SCHEME.—A correspondent has sent from Oporto for distribution a quantity of the protecting case of the flower cone of *Pinus pinaster*. The scales can be either mounted in balsam, or viewed as opaque objects. I shall be pleased to send a small quantity to applicants sending a stamped addressed envelope, accompanied by the coupon to be found in the advertisement pages of this issue.

NOTES AND QUERIES.

G. Damant (China).—On examining the specimens in the tube which you have sent, I found that two parasites were adherent to the abdomen of the cockroach. These are larvæ of the genus Rhipidophoridæ, and the winged specimen is the perfect insect. These parasites are nearly allied to the British *Metoecus paradoxus*, which is a parasite of the wasp. You cannot do better than proceed with the mounting of your insect parts in the manner described by Mr. Cole in *Modern Microscopy*. In order to overcome your difficulty with the insect mouth organs, etc., you will proceed as far as the clove oil stage, then take a slide and place the parts upon it in the desired position in a very little clove oil; generally there will be enough oil about each part without adding any more. Now place a cover-glass over all, being careful that the specimens do not move, then apply some thin Canada balsam solution to the edge of the cover and let it run under so that it goes all round the specimens. There will probably be some air-bubbles, but they should be disregarded, they will disappear as the balsam dries. Put the slide aside for, say, fifteen minutes, then add more balsam, and so on until the space between the cover and slip remains entirely filled up with balsam. It should then be allowed to dry for a few days, wash off any excess of balsam with benzole, apply a coat of black varnish, let this dry, clean the slide with turpentine, and add another coat of varnish.

G. V-G.—All the objectives you name are high-class, but I am inclined to recommend for your special purpose the one made by Leitz. The lenses of smaller aperture for work on Diatoms would certainly not be so advantageous.

W. D. D.—The parasite of the *Hydra fusca* is *Trichodina pediculus*.

T. P. Thomson.—I am much obliged for your proposal, but am afraid that Diatoms of your locality would not be of general interest unless indeed you had discovered some new or very rare species.

G. F. Brown.—If you will kindly send me another sample of the Polyzoa, I will endeavour to identify it for you.

W. F. Albrow.—I have communicated with the consultant who interests himself in the particular department to which your query refers, and he suggests that the peculiar substance which you have found in your flagon of distilled water may be due, as you suggest, to a dirty vessel, in which case the growth would perhaps be a fungoid or gelatinous bacterial one, detached from the bottom of the vessel by the act of emptying it. He further suggests that it might perchance be due to the solvent action of the water detaching portions of the surface of the glass. This is common with alkaline solutions, especially ammonia, though the large size and circular shape of the described growth are difficult to reconcile with this idea. If any of the substance is still obtainable, the consultant would be particularly interested in examining it.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office, 326, High Holborn, W.C.*

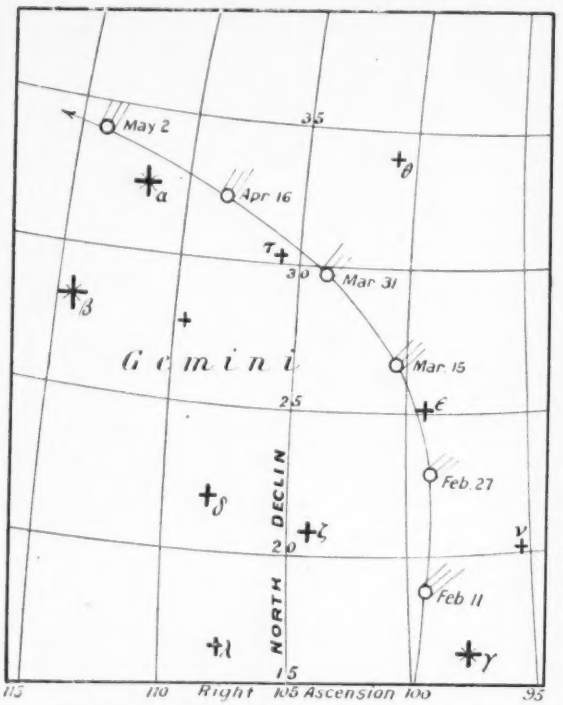
NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

GIACOBINI'S COMET (1902 d).—This object continues well visible in pretty good telescopes, though it is decidedly small and inconspicuous. In March and April the comet will travel slowly to the

north-east amongst the stars in the northern region of Gemini. An ephemeris was given in KNOWLEDGE for February, 1903, and the following diagram will indicate the apparent path of the object until May. The motion of the comet will carry it near several fairly bright stars which will greatly facilitate its identification:—

March 7 ... Comet ½° South of ε Geminorum (Mag. 3·2).
April 8 ... Comet ½° North of τ Geminorum (Mag. 4·6).
„ 26 ... Comet 1½° North of α Geminorum (Mag. 2·0).



Path of Giacobini's Comet (1902 d). 1903, February 11—May 2.

The remarkable feature in connection with this comet is its great perihelion distance, which amounts to 2·75, or 256 millions of miles, and exceeds that of any other comet observed since 1729. The bright comet of that year had a perihelion distance of 4·0435, which is equivalent to 380 millions of miles! Barnard's comet of 1885 (IV.) was also somewhat exceptional in regard to the wide interval (2·295, or 213 millions of miles) separating it from the sun, but our present visitor is much more remarkable in this respect.

GIACOBINI'S COMET (1903 A).—A comet was found at Nice on January 15, near β Piscium, and the position fell so near the ephemeris place computed for Tempel-Swift's comet that at first some uncertainty was felt whether it was a new object or a return of the periodical comet referred to. But the motion was soon found incompatible with that of the latter; the object proved a new comet approaching its perihelion and rapidly becoming brighter. Its motion was carrying it to the N.E., and at the opening of March the comet may be found close to γ Pegasi (*Algenib*), and will be nearly twelve times as bright as on the date of its discovery, when it was estimated of the 10th magnitude.

THE QUADRANTIDS.—The January Quadrantids, or Boötids, as they might more fittingly be designated, seeing that the small asterism formed by Bode (1801) between Boötes, Draco and Hercules, and called Quadrans Muralis, does not seem likely to be acknowledged either by present or future astronomers. There is always, however, a serious objection to changing a name which has become familiar by long usage, for doubts and complications naturally ensue, and it is questionable whether it is not desirable to retain an old title, inappropriate though it may appear, preferably to an alteration which must induce confusion.

The January meteor shower was fairly well observed this year, though the weather was very unsettled. On January 2 the display was extremely feeble; the maximum occurred on January 3, but it by no means formed a bright and abundant return. The mean position of the radiant derived from a number of independent determinations was at 228°+52°. In the *General Catalogue of Radiants* (1899) the average centre from 32 positions is at 230°·6+51°·1. Three pretty bright Quadrantids were doubly observed, and their real paths worked out as follows:—

1903.	G.M.T. h. m.	Height at beginning.	Height at ending.	Length of Path.	Velocity per sec.	Radiant. ☌ ☌	Position over.
Jan. 3.	7 25	60	47	52	16	228+52	Wilts.—Hants.
„	12 5	65	49	41	26	228+53	Herts.—Bucks.
„	12 59½	67	54	30	20	227+50	Berks.—Hants.

A considerable number of pretty bright meteors (chiefly Quadrantids) were recorded, but the above appear to be the only accordances, for the observers were rarely watching the sky simultaneously.

FIREBALLS.—Several fireballs and bright long-pathed meteors were observed in January. Three of these made their apparitions during the severe frost and clear moonlit nights which prevailed during the second week of the month. Appearing as they did near the period of the full moon these objects managed to elude regular meteoric observers, but a considerable number of descriptions have been received from other sources. Fine meteors were also seen on January 25 and 28, and the following is a summary:—

January 10, 9h. 30m.—Brilliant fireball, about one-third as bright as the moon, directed very slowly from a radiant in Monoceros. Height 63 to 31 miles, and velocity 18 miles per second. An observer in N. Kent describes it as "a large comet with a tail of golden sparks only a few yards away, and coming within half a yard of the ground, then slowly ascending, wriggling like a serpent, until it mixed with the stars." 11 observations.

January 13, 6h. 15m.—Bright, long-pathed, rocket-like meteor ascended from N. horizon and passed to S. over western counties of England. Height about 55 miles, and luminous flight of about 200 miles traversed at about 34 miles per second. Radiant near γ Boötis. 3 observations.

January 14, 7h. 7m.—Fireball about 2 × ♀, with slow horizontal flight over Rutland, Leicester and Stafford at an elevation of about 57 to 54 miles. Velocity 21 miles per second. One observer at Highgate, N., guesses the time of apparition as 5 or 6 minutes after 7, and says "the air was too cold for me to take my watch out." Radiant in Monoceros near E. horizon at 120°—3°. 8 observations.

January 25, 7h. 59m.—Fine meteor of Jovian lustre travelled from S.E. to N.W. from over Surrey to Warwick, descending from a height of 95 to 16 miles. Radiant near ζ Geminorum. 4 observations.

January 28, 11h. 44m.—Fireball equal to Venus, with a long flight and slow apparent speed. Fell from a height of 62 miles above a point W. of York to 41 miles above a point closely E. of Bristol. Path 181 miles, and velocity about 20 miles per second. Radiant at 280°+43° near α Lyræ, close to the N. by E. horizon. This meteor was well observed by Prof. A. S. Herschel, Slough, Mr. T. W. Backhouse, Sunderland, Mr. J. H. Bridger, Farnborough, Dr. H. Whichello, Chester, and others. 12 observations.

THE FACE OF THE SKY FOR MARCH.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the sun rises at 6.50 and sets at 5.36; on the 31st he rises at 5.43 and sets at 6.28, thus during the month the day lengthens by 2 hours.

Spring commences at 7 P.M. on the 21st, when the sun enters the sign of Aries.

Sun-spots are of more frequent occurrence, and the sun's disc may be examined for small spots with some hope of reward.

The Zodiacal Light is now in the most favourable position for observation in the west for two or three hours after sunset.

There is an annular eclipse of the sun on the 29th, invisible in this country but visible over Eastern Asia.

THE MOON:—

	Phases.	h. m.
Mar. 6	☽ First Quarter	7 14 P.M.
„ 13	○ Full Moon	0 13 P.M.
„ 21	☾ Last Quarter	2 8 A.M.
„ 29	● New Moon	1 26 A.M.

The moon is in perigee on the 10th, and in apogee on the 22nd.

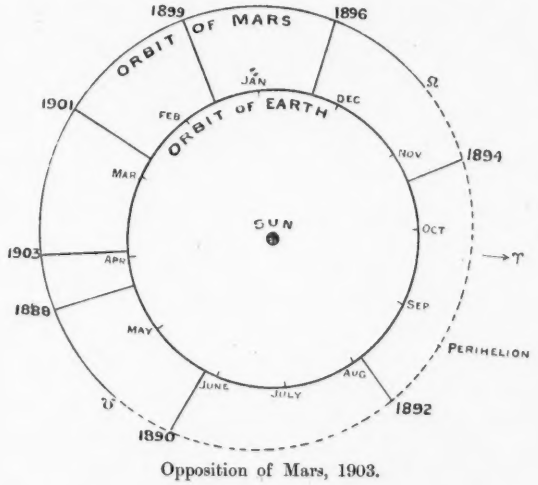
OCCULTATIONS.—The following are among the principal occultations visible at Greenwich :—

Date.	Star Name.	Magnitude.	Disappearance.			Reappearance.			Moon's Age.
			Mean Time.	Angle from N. Point.	Angle from Vertex.	Mean Time.	Angle from N. Point.	Angle from Vertex.	
			h. m.	°	°	h. m.	°	°	d. h.
Mar. 9	51 Geminorum	5·4	0 23 A.M.	153	113	1 1 A.M.	231	190	9 14
,, 10	α Cancri	4·3	4 59 P.M.	68	108	5 50 P.M.	316	353	11 7
,, 14	B.A.C. 4294.	6·1	9 29 P.M.	141	174	10 26 P.M.	264	292	15 11
,, 18	ζ^2 Libræ	5·8	1 6 A.M.	120	144	2 21 A.M.	274	288	18 15
,, 18	ζ^1 Libræ	5·4	2 41 A.M.	141	152	3 47 A.M.	250	251	18 16
,, 19	χ Ophiuchi	5·0	4 1 A.M.	94	100	5 25 A.M.	284	276	19 18

THE PLANETS.—Mercury is visible for the first few days of the month as a morning star in Capricornus. He is not favourably placed, and rises at the beginning of the month only about one hour in advance of the sun.

Venus now shines brilliantly in the western sky, and since the planet can be seen before it is dark she is available for observation for a considerable time. On the 1st she sets about 7.40 P.M., or 2 hours after the sun, and on the 31st at 9.15 P.M., or $2\frac{3}{4}$ hours after sunset. The apparent diameter of the disc is increasing; at the middle of the month it is 11″·4, whilst 0·9 of the disc is illuminated.

Mars is now at its best for easy observation, as the planet is in opposition to the sun on the 29th. The present opposition is more favourable than that of 1901, in that we approach nearer to the planet by some $3\frac{1}{2}$ millions of miles, the apparent diameter of the planet being 14″·57 as compared with 14″·17 at the last opposition. As will be seen from the appended diagram, the present opposition is not one of the most favourable, since the distance of the planet from the earth is 59 millions of miles, whilst under the best conditions the distance is only 35 million miles.



Opposition of Mars, 1903.

The latitude of the planet's centre is + 22°, thus the north polar cap is presented to us, and it is winter in the Martian southern hemisphere. On the 1st the planet rises at 8.30 P.M., and on the 31st at 5.45 P.M. The planet is describing a retrograde or westerly path in Virgo, and on the 22nd of the month will again pass close to γ Virginis.

Jupiter and Saturn are unobservable, being too near the sun.

Uranus is a morning star in Ophiuchus, rising about 3 A.M. near the beginning of the month. The planet is in quadrature with the sun on the 17th.

Neptune is on the meridian about sunset near the middle of the month; he is in quadrature with the sun on the 22nd. The planet is pratically stationary throughout the month, and is situated 5 minutes west of γ Geminorum and 10′ south.

THE STARS.—About the middle of the month at 9 P.M. the positions of the principal constellations are as follow :—

ZENITH . No bright constellations in the zenith.

SOUTH . Cancer and Hydra on the meridian; Gemini high up, *Procyon* and *Sirius*, all a little to the west. Orion is to the south-west, and Leo (*Regulus*) to the south-east high up.

WEST . Taurus, Aries nearly setting, Auriga (*Capella*) high up. To the north-west Perseus, also Andromeda low down.

EAST . Virgo (*Spica* rising), Bootes (*Arcturus*). To the north-east Ursa Major high up, Corona, Hercules and *Vega* low down.

NORTH . *Polaris*; to the right, Ursa Minor, Draco; below, Cygnus, Cepheus; to the left, Cassiopeia.

Minima of Algol occur on March 12th at 2.51 A.M., on March 14th at 11.40 P.M., and March 17th at 8.29 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of February Problems.

No. 1.

(C. C. W. Sumner.)

Four Solutions (R to QB3, R × B, Kt to B3ch, Kt to B6ch). I must apologise for inadvertently printing this "revised" version of a position which appeared last year, particularly as the results of the revision have been so unsatisfactory.

No. 2.

(A. Lillie.)

Key-move.—1. B to Ktsq.

If 1. . . . K × Kt, 2. K to B2, etc.
1. . . . K × P, 2. Kt to B6 or 2ch, etc.

[Two or three solvers have found themselves in the same predicament with regard to this problem as the composer.]

SOLUTIONS received from "Alpha," 2, 4; W. Nash, 3, 4; G. A. Forde (Capt.), 2, 4; "W. Jay," 3, 4; "Endirby," 3, 4; "Looker-on," 3, 4; A. H. H. (Croydon), 3, 0; W. H. S. M., 3, 4; G. W. Middleton, 3, 0; J. W. Dawson, 3, 0; "Quidam," 3, 4; J. W. Dixon, 3, 4; C. Johnston, 3, 4; H. S. Brandreth, 2, 4; H. F. Culmer, 2, 4.

J. W. Dixon.—Yes, postcards are more convenient.

W. Nash.—You are quite right in assuming that three points is the maximum for a two-mover, and six points for a three-mover. I quite agree with your estimate of *Fort Nachanand*, if only it had been sound.

"*Endirby.*"—Only two keys to a problem can score points. Duals no longer count this year.

L. C. T. (India).—The solutions for which you ask are as follow: W. H. Gundry (July, 1900), Kt to Q4; A. F. Mackenzie (August, 1900), B to R5 (or B to QB7); this is a two-move problem, erroneously printed as a three-mover. B. G. Laws (June, 1900), incorrectly diagrammed, and reprinted in the following number. The White Knight at QRsq should be a King. Solution Kt to B6.

J. C. Candy.—Thanks for the problems. You will see that I have at last found room for your former batch.

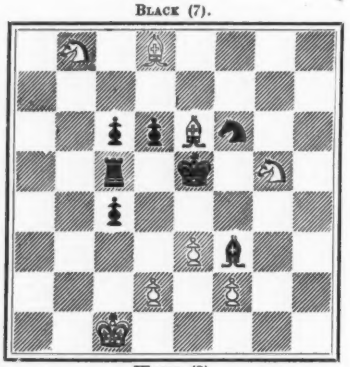
W. Jay and G. Woodcock.—Any criticisms of the problems at present would, I think, be premature.

PROBLEMS.

By J. C. Candy.

No. 1.

BLACK (7).

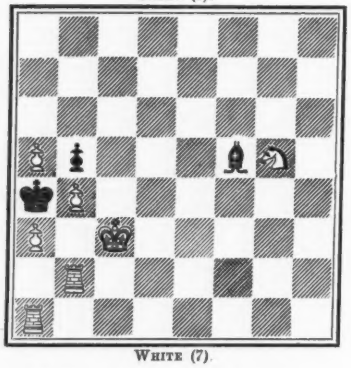


WHITE (8).

White mates in two moves.

No. 2.

BLACK (3).



WHITE (7).

White mates in three moves.

[As our stock of problems is now nearly exhausted, we hope that those readers of this page who are composers will send some of their compositions in either two or three moves.]

PROBLEM TOURNEY.

Through the courtesy of the six solvers who are acting as preliminary judges in the tournament, I am able to publish their award this month, and shall hope to give my final award in the April number. The following problems have received votes:—

PROBLEM.	J. D.	W. J.	C. J.	L-O.	W. N.	G. W.	TOTAL.
No. 1	6	—	—	—	—	—	6
No. 4	8	—	—	8	7½	6	29½
No. 6	—	9	6	9	—	—	24
No. 10	6	—	—	10	6	—	22
No. 12	—	5½	8	7	—	7	27½
No. 13	6	7	7	—	—	5	25
No. 17	—	5½	—	—	5	—	10½
No. 18	10	10	9	6	9½	9	53½
No. 20	—	—	—	—	7½	—	7½
No. 24	—	8	10	5	—	10	33
No. 26	9	—	5	—	9½	8	31½

The main gap in this list evidently comes between Nos. 10 and 17, whereas Nos. 6 and 10 come very close to No. 13. I have therefore decided to select the first eight in the score, viz.:—No. 4, "Three Steps and a Shuffle-off"; No. 6, "Trifolium Duplex"; No. 10, "Possibilities"; No. 12, "Ariadne"; No. 13, "Leonard"; No. 18, "Bargany"; No. 24, "Weighty"; and No. 26, "Ben Trovato." The overwhelming preponderance of votes given to No. 18 is the most remarkable feature of the list. Until I come to scale the problems I cannot, of course, say whether it will maintain its lead.

CHESS INTELLIGENCE.

The third International Tournament at Monte Carlo is now in progress. The list of competitors is greatly weakened by the absence of Messrs. Janowski, Lasker, and Tchigorin. It is a two-round competition, the players being Albin, Marco, Maroczy, Marshall, Mason, Moreau, Mieses, Pillsbury, Reggio, Schlechter, Tarrasch, Taubenhaus, Teichmann, and Wolf. As might be expected, Mr. Pillsbury has already obtained the lead, while Maroczy and Teichmann have also made a good start.

We much regret to record the death of Mr. James Innes Minchin, for many years Honorary Secretary of the St. George's Chess Club. Mr. Minchin was, after Professor Wayte, probably the strongest of the regular players in the club, and took a leading part in promoting the International Tournament of 1883.

All manuscripts should be addressed to the Editors of KNOWLEDGE, 326, High Holborn, London; they should be easily legible or typewritten. All diagrams or drawings intended for reproduction, should be made in a good black medium on white card. While happy to consider unsolicited contributions, which should be accompanied by a stamped and addressed envelope, the Editors cannot be responsible for the loss of any MS. submitted, or for delay in its return, although every care will be taken of those sent.

Communications for the Editors and Books for Review should be addressed Editors, KNOWLEDGE, 326, High Holborn, London.

SUBSCRIPTION.—Annual Subscription, throughout the world, 7s. 6d., post free.

BOUND VOLUMES.—The yearly cloth-bound Volumes, 8s. 6d.; postage extra.

BINDING.—Subscribers' Numbers bound complete, 2s. 6d. each Volume; postage extra. Cases for Binding sold separately, 1s. 6d. each; postage extra.

LANTERN SLIDES of many of the Plates appearing in KNOWLEDGE may be obtained from Messrs. Newton & Co., 3, Fleet Street, London.

REMITTANCES.—All remittances should be made payable to the Publisher of KNOWLEDGE.

For Contents of the Last Two Numbers of "Knowledge," see Advertisement pages.